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U1432450

Exchange Traded Fund Asset Class Correlations

A dissertation submitted in partial fulfilment of the requirements of the Royal Docks Business School, University of East London for the degree of **Finance and Risk MSc**

August 2015

Word count: 13, 860

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Abstract

This dissertation is an investigation into return correlations among major asset classes currently traded in exchange traded funds (ETFs). The asset classes cover equities (split into small, large and a broad equity universe), fixed income, REITS (Real Estate Investment Trusts), Private Equity, commodities and currencies. The scope is to examine correlations under differing market structures, investigating the relationship across geographic and global markets. The analysis considers the time period 2003-2014, and compares correlations before, during and after the 2008 financial crisis. Various geographical markets are covered; including U.S., Global, UK, Europe, Australia, Japan and BRICS markets (minus South Africa).

The analysis finds evidence weekly returns for all assets follow a negatively skewed leptokurtic distribution. The main conclusions drawn are that asset return correlations appear higher under Bear than Bull Markets and fixed income and currencies have a unique correlation structure against other assets. REIT and Private Equity both make similar returns at a similar risk level and have similar correlations to equities but Private Equity has large management fees and large price-tracking errors, eliminating any possible diversification benefits. Hence REITs and Commodities currently offer the best options to diversify an equity portfolio beyond fixed income securities. An analysis of asset return against risk shows in general an investor must accept more risk to generate higher returns. Small Cap Equites are found to behave in the same way as Large Cap but evidence is found of consistently greater returns. The evidence of differing correlations between major assets in the ETF market provides substantial evidence a diversified liquid portfolio can be constructed using only the ETF market.

Acknowledgements

Firstly I would like to thank my supervisor, Dr Peiyi, for her time, patience and guidance at different stages of the research project.

Secondly I would like to thank family members for proof reading at several points of the writing process.

Contents

1. Introduction

1.1 Asset Return Correlations

A basic tenant of successful investment finance is maximising return while minimising risk. Managing risk is normally achieved by hedging or diversifying held assets. In both of these cases understanding the correlation in returns between assets is vital. Markowitz (1952) with his mean-variance approach shows the importance of understanding asset return correlations especially when minimising risk and maximising returns in an investment portfolio. To efficiently diversify a portfolio, managers must choose assets with low correlations to offset individual asset risk. Purchasing additional securities within the same asset class can offer diversification benefits but these are normally limited since normally a high return correlation exists between securities in the same asset class. Statman (1987) shows to achieve a well-diversified stock portfolio, at least 30 stocks must be included, which contracts the risk down to systemic (market) risk only. Therefore there is strong justification for most investors who would like to invest in stocks to invest in broad indices and minimise their exposure down to the underlying systemic risk of the market. To do this investors could choose to purchase shares of every stock included in the index. However this can be prohibitively expensive considering transaction costs, therefore it is much more common for small and medium sized investors to use index funds to achieve exposure to stock risk and returns.

Other assets exist beyond stocks. They are known as alternative assets and can help to diversify risk further. These asset classes include (among others) Fixed Income, Real Estate, Private Equity, Commodity and Currency. When constructing a portfolio the bulk of returns come from choosing the correct asset class rather than choosing the correct securities within that asset class. This is due to the fact that different assets have different return structures and therefore can perform very differently under different market structures. In light of this traditional portfolio diversification is done by purchasing across asset classes; for example purchasing bonds and real estate along with stocks. The two most traditional asset classes are stocks and bonds

which form the base of almost every investment portfolio for a stock market investor. Ebens et al. (2009) show a portfolios risk is highly dependent on correlation between held assets. Low correlations provide high diversification benefits on their four asset portfolio consisting of stocks, bonds, currency and commodities. Therefore understanding the correlation between assets is vital to managing risk.

1.2 Exchange Traded Funds

An Exchange Traded Fund (ETF) is an investment vehicle which offering an alternative to mutual or hedge funds. Investors buy shares in a fund which is built to follow returns of an underlying index. These shares are identical to one another and therefore can be exchange-traded, offering greater liquidity and ease of use over mutual funds. The fees and expenses are generally much lower than mutual funds and minimum investment is much lower at the price of one share.

There is a trend in the finance sector towards passive (rather than active) investment. With a passive investment style, broad indexes are chosen over individual securities, minimising individual security exposure and only systemic risk of each index remains. ETFs have allowed this style to flourish since they offer lower management fees and greater ease of use than older index-following mutual funds which generally have high frontload or back-end fees. DiLellio and Jakob (2011) show that ETFs allow a reduced cost to reach other asset classes compared to mutual and index funds. And that ETF only strategies could allow outperform buy-and-hold benchmarks, even when considering transaction and bid-ask spread costs. Therefore ETFs are more attractive to implement a passive investment strategy.

ETFs represent many different underlying assets, allowing the construction of diversified portfolios containing more assets at a lower cost than feasible in the past, especially for relatively small and medium-sized investors. Therefore an investigation into correlations between different assets and among different market conditions will be worthwhile in order to check if

different assets still behave as traditionally expected when modelled as ETFs. ETFs have exploded in popularity in recent years due to their ease of use from high liquidity and passive investment features such as index-tracking. Therefore, a high degree of diversification can in theory easily be obtained by holding just one or two ETFs. Another advantage is that since ETFs are based on their underlying assets value, arbitragers will maintain value, for example by choosing to buy undervalued ETFs and sell their component parts for an easy profit. Demaine (2002) explains that new ETFs can be constructed if there is over-demand for a particular ETF, pushing price down to the correct underlying level. Finally ETF liquidity is dependent on the liquidity of the assets constituting the underlying index and a large part of demand for ETFs is the "appeal of instant, cost-efficient diversification".

ETF issuers create their revenue from expense ratios and lending out securities held and the overall industry generates billions every year. To conclude, ETFs have become very popular because of their high liquidity, low costs and easy access to exposure of every major asset class, hence they offer a cheap method to construct a well-diversified portfolio.

1.3 Different Market Structures

As previously stated asset-class selection is much more important than security selection; therefore it is important to explore how and if asset-return correlations change under different market conditions. Market conditions or market structure can be defined in several different ways. For example, growth, inflation, volatility and market liquidity are all factors (often cross-correlated) that need to be taken into account when making investment decisions. Alternatively a broader picture can be constructed by looking at the overall market such as comparing periods of recession or market growth. This is similar to looking towards periods of crisis against 'normal' market conditions. In this case the recent global financial crisis will be compared to pre and post-crisis levels.

The scope of this dissertation is to examine overall asset correlations rather than specific asset classes; therefore the correlations will be compared to the overall market condition of growth or recession; signified by a Bull or Bear market in world equities. Changing market conditions are important since they lead investors to rebalance their portfolios to flee higher risk assets in search of stable, if lower, returns. However, if asset correlations change with market conditions, these gains may be limited. Therefore it is important to investigate how, and if, correlations change with respect to the previous market structure and to the overall correlation between the assets. Previous work such as Bernhart et al (2011) investigated correlation structures in U.S., European and Asian markets using the major stock-indices to identify calm and turbulent market periods. Their findings show that the correlations are far from being stable and change significantly between market periods.

It is important the different market structures are covered since investors will change their investment strategy under differing market conditions. In turn, this could affect the correlations between different assets. For example, in uncertain times there can be a 'flight to quality' where assets with perceived higher volatility are sold and those with low volatility bought. Waggle and Moon (Fall 2005) show that changes in the expected stock-bond correlation leads to investors rebalancing their portfolios and therefore, asset correlations are very important for asset allocation decisions.

1.4 Research Question and Hypotheses

The key research question for this dissertation is to investigate asset return correlations in ETF markets. Especially to investigate how the correlations change between world Bear and Bull equity markets. The work will provide evidence if ETFs alone can form an efficiently diversified portfolio. Additionally, by separating out Small and Large Cap equities, the analysis can give insight into whether equities should be considered as one broad class or differing sub classes.

The investigation will be extended across different geographical markets, incorporating both developed and developing countries. To further the study, the overall global market will also be considered. Correlations between ETF asset classes will be analysed, covering Small and Large Cap Equities; Fixed Income, REITs, Private Equity, Commodity and Currency classes.

A basic hypothesis to be confirmed is that of risk premia; namely that to achieve higher returns an investor must take higher risks, and the higher returns are a form of compensation for this. The risk-return graphs of all assets in each market should reveal this result if they show a strong positive linear correlation between risk and return.

Finally, the Equities or Stocks asset class will be split into Small and Large Market Capitalisation sizes to look for evidence of investors being justified in their separation.

The hypotheses are summarised below:

Main hypothesis: *ETF asset correlations change depending on Bear and Bull markets*

Additional hypothesis 1: *ETF assets show that to achieve higher returns greater risks must be taken (risk premia).*

Additional hypothesis 2: *Small cap equities behave differently to Large Cap equities*

This dissertation will investigate the correlation returns in ETFs based on different asset types. Testing across different market structures including Bear and Bull markets and different geographic markets with various states of development will be investigated. By focusing on different asset classes the different idiosyncratic risks can be investigated. The use of ETFs is to prove an easily applicable investment strategy that is easily implemented in practice and not limited to a theoretical perspective. Hence work which further explore the relationship between asset correlations is valuable to the finance sector.

1.5 Chapter Layout

Chapter 2 contains the literature review with previous work done on ETFs and asset return correlations. Chapter 3 covers the research methodology with the assumptions taken and the checks needed to be made to lead to reliable conclusions. Chapter 4 contains the data analysis and results tables with conclusions found and compared between each market studied. Section 4.8 contains an overview conclusions gathered and return-correlation heat maps for all markets which give a good snapshot of the final results. Chapter 5 is a summary of the work done and resultant conclusions along with some of the possible implications of these conclusions. Finally Chapter 6 gives recommendations for future work to extend analysis with areas for further investigation.

1.6 Summary

This dissertation will investigate correlation returns in ETFs based on different asset types. Testing across different market structures including Bear and Bull markets and different geographic markets with various states of development will be investigated. By focusing on different asset classes the different idiosyncratic correlations can be investigated. Equities will be split by size to examine if differing correlation behaviours can be observed. The use of ETFs is to prove an easily applicable investment strategy that is easily implemented in practice and not limited to a theoretical perspective. Hence work further exploring the relationship between asset correlations is valuable to the finance sector.

2. Literature Review

This section will critically evaluate previous academic work in relevant areas, including passive investment, asset classes, ETFs and asset correlations. Furthermore, the reasons for hypotheses presented in section 1.4 will be fully developed.

2.1 Passive Investment

Vargas and Ferruz (2007) show that due to the difficulty in correctly picking market timing, active management is inferior to passive or indexing strategies. These passive and indexing strategies for the purposes of this dissertation will define passive investment. Another definition could be defined as choosing to go long in broad indices of assets where no specific securities are chosen to be bought or sold according to predefined rules or qualities. In this sense transaction costs can be negated since an ETF would only have to be bought and sold once to realise any returns; with a large enough investment transaction fees of ~£16 total (at time of writing) vanish into insignificance. Wellington (1997) explains the advantages of passive investment management include a reliable method to replicate returns for a specific asset class. Additionally, no timing, forecasts or analysis are needed to select specific securities; along with reduced trading costs, they lead to a low cost strategy. Active investment strategies generally rely on market timing, buying and selling specific securities at the correct time; hence transaction fees must be taken into account and can have a large effect on returns.

While some active investors have been wildly successful, most academic literature points towards passive investment strategies being, on average, more successful. Gulko (2005) demonstrates that passive beats active investment even in a market populated by individual behavioural biases, so long as prices are still efficient. In the world of ETFs arbitrageurs make prices efficiency very likely, especially in relatively liquid assets such as stocks. Vermorken et al (2013) make a damning argument against active investment

by showing “managed long-only equity portfolios do not show a higher probability of outperforming the index than randomly selected ones”. Showing active management security selection was no better than choosing securities randomly. Further evidence is provided by Malkiel (2003) arguing in favour of passive investment in all markets, including Small and Large Cap equities, bond and international markets. Garcia and Gould (1991) show that it is difficult for active managers to outperform the index, but that in choosing a passive strategy, the investor is in fact investing in all active strategies currently employed in the market at that time since the index must be the total holdings of all managers. The counterpoint to passive management is the guarantee that the index return will not be beaten, whereas some active managers may beat the market long term through either luck or skill. The difficulty for investors has always been consistently picking managers who will beat the index next year.

Therefore the rise in passive over active-investment is primarily due to the difficulty in choosing an active fund manager who can consistently outperform the market, their target benchmark or relevant peers. Additionally, excessive returns can be achieved by taking excessive risk which can result in investors taking more risk than they ideally prefer. Moreover these returns are not “risk-efficient”, meaning that greater risks are being taken to achieve the same returns. In the longer term, through compounding, this can have large cumulative effects on returns.

One method to lower risk is through diversification and broadening exposure away from any one particular individual security or asset. As more assets are included into the portfolio, all risk (other than systemic) can be diversified away. Therefore, with passive investment the asset risk will be limited to the systemic risk of each particular asset and each individual security risk will be minimised. As mentioned in section 1.2, index-based investment can be achieved by purchasing each security in the index, using an index fund or purchasing an ETF. With the massive growth in the ETF universe many different assets can now be bought easily and in a much more piecemeal or granular fashion.

Logically, this leads to the question of what are the main different asset classes that the majority of investors would look for in order to form a diversified portfolio. This is the subject of investigation in the next subsection.

2.2 Asset Classes

Ibbotson and Kaplan (2000) demonstrate that asset allocation explains about 90% of a funds returns over time. Clearly, asset selection is vastly more important than security selection for investors' returns. The following section argues the choice of asset classes.

The choice of asset classes was made so it could to be relevant for the vast majority of traditional investors and so the correlations identified would give a broad picture of each asset class. Yonggan and William (2002) explains portfolio diversification gains are made by combining stocks with differing expected returns and variances. Some investors have differing objectives when constructing a diversified portfolio, for example, an end-of-horizon investor who concentrates on assets with high liquidity or cash-flow qualities. Alles and Murray (2009) investigate this and show differing investment horizons influence investment outcomes. These investors will still find asset correlations useful to diversify but may have other overriding objectives that influence their portfolio decisions.

Another notable style of investment is Factor-based investment; in this style specific risk factors such as value, momentum, growth and volatility (among others) are identified. Fama and French (1992 and 1993) identified 2 factors which are size and value; significant in explaining a stock portfolio's returns. Sloan (1996) identified the quality factor and Carhart (1997) extended the model to include the momentum factor. These factors are used by investors to choose specific stocks which should, in theory, do better than the broad stock universe. In the ETF universe these factors are represented by specific factor ETFs; for example iShares by BlackRock offer factor strategy EFTs covering value, size, quality, momentum, and volatility. While Factor

investing is undoubtedly popular, it only covers equities and as Brinson, Hood and Beebower (1995) show; asset allocation decisions affect more than 90% of a portfolio's performance. Consequently, only the size-factor will be included and other factors left for future work. This area is large enough to deserve its own focused work, especially since equities make up a majority of most portfolios.

Sections 2.2.1 and 2.2.2 will discuss Equities and Fixed Incomes and sections 2.2.3-6 Alternative assets. Alternative assets can include many varied classes, including unique assets such as artwork, stamps and even wine. These assets are not common and do not play a large role in financial markets and are therefore beyond the scope of this work. Other alternative assets available to all investors, modelled by ETFs, will be analysed, including REITs, Private Equity, Commodities and Currency.

2.2.1 Equities

Equities, also known as stocks or shares are the most common investment vehicle. Company shares are bought and sold widely on global stock markets and are the constituents of most indices. Therefore, Equities are the first and most important asset candidate to be included since they represent a majority in most traditional portfolios. Booth and Fama (1992) show that diversification between U.S. equities and Treasury Bills improves portfolio compound returns and that active-management's performance against a benchmark is generally from a luck rather than skill. Additionally, small cap stocks are shown to benefit greatly from diversification since their risks can be reduced the most. Fama and French (1992 and 1993) show that market capitalisation size is influential to returns. Since the equity universe is so large, the market will be split into Small and Large Cap to allow an analysis of whether small cap equities have differing performance and correlation qualities when compared with Large Cap equities.

2.2.2 Fixed Income/Bonds

Bonds or Fixed income is another obvious asset class that should be included. The differing return and risk performance against equities is well documented and Bonds normally make up the second largest weight in a traditional portfolio. The asset offers a regular fixed income, known as a coupon, until maturity in return for an initial payment (principal or par value). Bonds can be issued by governments or corporations and come in many different maturities and coupon rates. Ratings agencies give bonds a rating, which signifies the probability of default. When a bond issuer defaults, they are unable to honour the remaining payments to the bond holder, in which case the investor can lose a large part of their investment. Therefore bonds with a low rating, known as junk bonds, are riskier than bonds with a high rating, known as investment grade bonds. Junk bonds have to offer a larger return to attract investment.

In keeping with traditional bond qualities the bond or fixed income asset class will be ideally represented by an ETF matching a rolling 5-10 year aggregate investment grade government and corporate bond index. Junk bonds offer greater returns but at a greater risk level and therefore will be rejected from the study. The maturity is aimed to be at the middle of what is available on the market and will therefore not be adversely affected high durations (interest rate sensitivity) at long maturities or short maturities where bonds generally have lower risk and yields. Consequently, this is a necessary oversimplification of the bond market but should give a reasonable picture of how the bond or fixed income asset class compares with other assets, and is an obvious method for a passive ETF investor to quickly gain exposure to the asset class. An extension of the work is to separate the class into its different subsections and is discussed as a recommendation in section 6.3.

2.2.3 Real Estate Investment Trusts

Real Estate is another popular investment class; investors desiring exposure could simply go and buy property. However, this has several disadvantages:

firstly, property is granular and additional investment requires large jumps of capital. Additionally, property is not liquid since it can take time to sell or purchase, and large losses or premiums will have to be paid to sell or buy real estate quickly. Real Estate Investment Trusts (REITs) offer investors a more liquid method to invest in real estate and earn dividends from rental incomes. Additionally, investing in a trust allows the benefits of a large portfolio of many types of real estate, diversified away from a single address. Brounen and Koning (2012) give a history in the rise of REITs and show REITs outperform their national indices 2000-2007.

2.2.4 Private Equity

Private Equity (PE) is an asset class defined by Woeller (2012) as "the private placement of money in a business venture" including "leveraged buyout, growth capital, mezzanine lending and venture capital" (pp. 1312) Woeller investigates Private Equity investments in BRIC countries, emphasising that the legal systems of developing countries may be unsuitable for Private Equity investment. Additionally, exiting investments may be difficult if an Initial Public Offering cannot be made on a domestic exchange. Comparison between developed and BRIC countries will test Private Equity asset behaviour.

Rizzi (2009) finds that PE modestly outperform the S&P 500 index before fees but not after, arguing that PE needs lower fees to remain a major asset class.

In terms of a passive investment, ETFs based on Private Equity will follow the returns of an index-based on Private Equity.

2.2.5 Commodities

Commodities are a difficult asset class to model. There are many subdivisions and methods used to model returns from commodities. A simple definition is that commodities are base materials used in future production of other goods; therefore obvious categories could be mining,

metals, energy and agriculture. In keeping with passive investment theory a commodities investment should be not disproportionately weighted towards a particular sector. This will require investment in commodity-indexes once more, in underdeveloped markets or some economies which are heavily weighted in one particular sector, not likely to be possible. Ideally, each market would have its own index that is equally weighted to all commodity areas. Considering the globally interconnected nature of today's markets and especially since commodities are transported all over the world, it may make more sense to use a global commodity index for all markets. This would help give a broad index of many commodities and ensure the same index methodology for all markets. Additionally, from a simple investment perspective, being more geographically diverse allows greater resilience to specific market shocks. Atwill (2012) argues that owning stocks in natural resource companies is less effective for diversification than futures-based commodity exposure. Therefore an ideal ETF used to represent commodities will use derivatives to represent the returns of a broad basket of resources.

2.2.6 Currency

Greer (1997) argues that currency represents one of three 'super-classes' of assets; consisting of capital assets, commodities and 'store of value' assets represented by currencies. The store of value is a replication of a 'carry' trade for that currency; which is the return gained from holding a particular currency against others, identical to a bullish currency strategy.

2.3 ETFs in the investment world

ETFs have increasingly become a cheap tool for asset allocation and now represent nearly every asset class available, Resnick (2011). Amenc, Goltz and Grigoriu (2010) show the diversification benefits of using ETFs to gain exposure to several asset classes and in their earlier paper Amenc and Goltz (2009) show, though a survey, liquidity is a key advantage of ETFs. Buetow and Henderson (2012) show the ETFs of less liquid asset classes (high yield

bonds, commodities and derivatives) have a tracking error compared to the underlying benchmark, meaning the benefits to diversification are less than implied by benchmark indices. However, this may just represent implementation costs. Additionally, higher correlations between the ETF and a U.S. equity index were found than between the benchmark index and a U.S. equity index. Both of these reasons mean it will be more accurate to use the ETF returns rather than the index returns where possible. Therefore as a minimum the ETF's chosen must closely track the underlying index, or an 'implementation error' assumed to be the difference. By using ETF's instead of indexes directly, return income will be more realistic since it will cover this 'implementation error'. Frino and Gallagher (2001) highlight the difficulties faced by ETFs in tracking the S&P 500. A study incorporating implementation gives much more relevance and realism to any results found.

ETFs can have lower fees than index-following mutual funds for several reasons. Firstly, the vast size of a major index ETF can reduce transaction fees considerably and no front-end or back-end fees (other than standard transaction fees) exist. Additionally, large financial institutions such as Barclays (and their trademark iShares) can benefit from economies of scale and further reduce transaction costs. Finally, every ETF has a 'creation unit' where if an investor requires a large number of an ETF's shares, they can have them created from the underlying bundles of securities included. As a result ETFs can have reduced liquidity until the creation unit number. For example, if 500 shares/day are generally traded in an obscure ETF, then trading 500+ shares will be very difficult. However, if a creation unit is 20,000 shares, then trading 20,000+ shares just requires a call to an authorized participant to have them created.

Some ETFs are very young; this means returns cannot be calculated. In this case the benchmark index can be used to generate a proxy for returns that would have been achieved. This is common practice in the finance industry and academic sector especially when constructing back tests. It is important when using indices that the index is a total return style, including any dividends that would have been received. The tracking error for the ETF

should also be low for the time period where data is available, ideally over the two types of market structure covered, proving that under normal conditions the index can be followed. Once these two requirements have been checked, the index returns can be considered feasibly achievable as investment in the ETF would be.

Tracking error is only a risk when buying or selling the security since there is a chance the price received will be different from the underlying value of assets in the index.

ETFs have a variety of methods used to replicate returns of the benchmark index. A Full Replication strategy simply purchases securities of the benchmark and holds them in the same proportions. Automatically, ensuring returns before expenses will be very similar to the index. Another strategy is the Optimisation method, where a sampling technique is used to define the securities that are most representative of the index; these securities are then purchased. The optimisation strategy is used when there are illiquid securities in the index which can therefore be expensive to obtain out-weighing the benefit of owning the security. The result can be that the Optimisation method can lead to a greater tracking error than the Full Replication method.

Finally synthetic replication strategies use total return swaps or derivatives to replicate the returns of an index or specific securities. Swaps and derivatives must exist for the relevant indices and securities for this to be possible and open up the ETF to be vulnerable to counterparty risk; where swap/derivative dealers default or fail to honour contractual commitments. Ideally, all ETFs chosen will use the same replication strategy in all markets for all assets since the risks will be similar. However due to different asset qualities and security liquidities this is highly unlikely to be possible. Each ETF chosen will have its replication strategy recorded in the relevant tables in section 3.7.

2.4 Asset Correlations

The next point to consider is why it is necessary for investors to focus on asset correlations. The reason for this is that asset correlations are directly linked to covariance by the formula:

$$\rho = \frac{cov\ (x, y)}{s_x s_y}$$

Where: ρ = correlation
$cov(x, y)$ = covariance of x and y
$s_x; s_y$ = standard deviation of x and y

The covariance is used in the mean variance approach developed by Markowitz (1952) to generate a portfolio, and is efficiently diversified based on historical data. Therefore, due the equation above if correlations change for any reason the optimum portfolio will change also and will need rebalancing. Correlations are a better number to analyse over covariance since the explanation and result is much more intuitive.

Previous work has shown that asset correlations can change under differing market conditions such as Chong and Miffre's (2010) analysis of commodity correlations against S & P 500 index; showing change in high volatility environments.

In this case the driving force to be tested will be whether the market is in a Bear or Bull state based on equity returns. Gulko (2002) shows that the correlation between U.S. stocks and bonds becomes negative when the stock market crashes; meaning that bonds are a good candidate for diversification during times of crisis, hence proving the importance of looking at correlations under differing market conditions. Since most portfolios are formed from a majority of stocks and bonds, a Bear market in equities is likely to have the most significance for investors. It provides the most information whether other asset correlations have changed over the same time, for example do other risky assets display the same correlation changes, as stocks and bonds.

Coaker (2006) furthers this work by studying the correlation between monthly returns of 15 asset classes with the S&P 500 in an 'up' market and

compares this to the correlation when the S&P 500 in a ‘down’ market. The study concludes that asset class correlation appears to be inherently unstable, however, cross asset class correlations were not measured and different geographic markets were not considered. This dissertation will look at those correlations for further analysis and compare the two Bull markets pre and post the 2008 financial crisis, which could point towards asset correlations being stable in each market type, but changeable depending on which market type is currently prevalent.

Longin and Solnik (2001) they use the MSCI world local index to identify market turbulence and argue an international investor would do the same. Bernhart et al (2011) show asset correlations change over turbulent and calm market periods (from 1987–2009). The analysis covered stocks, government and corporate bonds in U.S., European and Asian markets. They conclude correlations between assets vary significantly between market periods.

It is important to focus on a number of markets since the conclusions reached will be strengthened if they are consistent in a number of differing geographic and developed or undeveloped markets. Consistent correlation changes between assets will then seem inherent to those assets and not a coincidence particular to only one market.

Obviously, there are other factors that are important when choosing assets for a portfolio as Delcore (2010) points out; correlation is important for diversification but the return gap should also be considered. For this reason the risk of the individual assets should always be looked at when deciding on asset portfolio weights.

Correlation changes are shown to be important by Waggle and Moon (2005) who show that an increase in the expected stock-bond correlation leads to a shift from bonds to bills for more risk-adverse investors. Therefore, further analysis is justified between other assets to investigate if risk-adverse investors need to be wary of other correlation changes.

2.5 Conclusion

In summary, little has been done to compare performance of ETF's among different market styles. With the trend towards passive investment strategy, there is a large benefit to studying various ETF asset types and their relative performance in different market structures. In a passive strategy, ideally, the assets chosen are representative of the overall movement of that asset class and not heavily weighted towards one particular security. Hence the ETFs chosen should be truly representative of that asset class and not a subsector. The main results will be cross-asset correlations tables in Bull and Bear equity markets across a variety of developed and undeveloped (data permitting) markets. Additionally risk and return graphs will be constructed for each market to provide evidence if risk premia exist.

3. Research Methodology

3.1 Hypothesis

The hypothesis to be tested from Section 1.4 are restated below:

Main hypothesis: *ETF asset correlations change depending on Bear and Bull markets*

Additional hypothesis 1: *ETF assets show that to achieve higher returns greater risks must be taken (risk premia).*

Additional hypothesis 2: *Small cap equities behave differently to Large Cap equities*

3.2 Methodology Outline

The basic methodology is given here and will be justified in greater detail in relevant subsections.

Firstly it is key to identify the Bear and Bull markets from the time period and data available.

Next to identify ETFs for each asset class in each market and download the weekly last price and dividend information for both the ETF and its target index using the relevant tickers.

The data from Bloomberg is manipulated into weekly returns over the entire time period for each asset with index-return data filling any gaps missing in the corresponding ETF returns.

A graph will be made showing Weekly Return vs Weekly Risk to see if historically more risk had to be accepted to achieve greater returns and allowing visual testing of Additional Hypothesis 1.

From here the asset returns are divided into overall, Bull1, Bear and Bull2 market periods and imported into EViews to calculate the correlations and descriptive statistics. Analysis of these correlations and descriptive statistics

will be tabulated and provide insight into the main hypothesis and additional hypothesis 2.

3.3 Identifying Market Types

All data was collected from Bloomberg. The data must cover different market types during 2003-2014 for ETF correlations to be collected.

Therefore the first objective is to identify the Bull and Bear market periods. Considering the interconnectedness of financial markets it seems sensible to identify the market structure on a global level. Since this dissertation focuses on ETFs this work can only focus on time periods since ETFs became widespread. By 2002 Standard & Poor have introduced SPDRs; Barclays Global Investors have launched the iShares line; Vanguard have entered the market and bond funds have been generated. As the ETF market has developed more assets have been developed as ETFs but certainly no data should be used before 2002; since the market is still in its infancy.

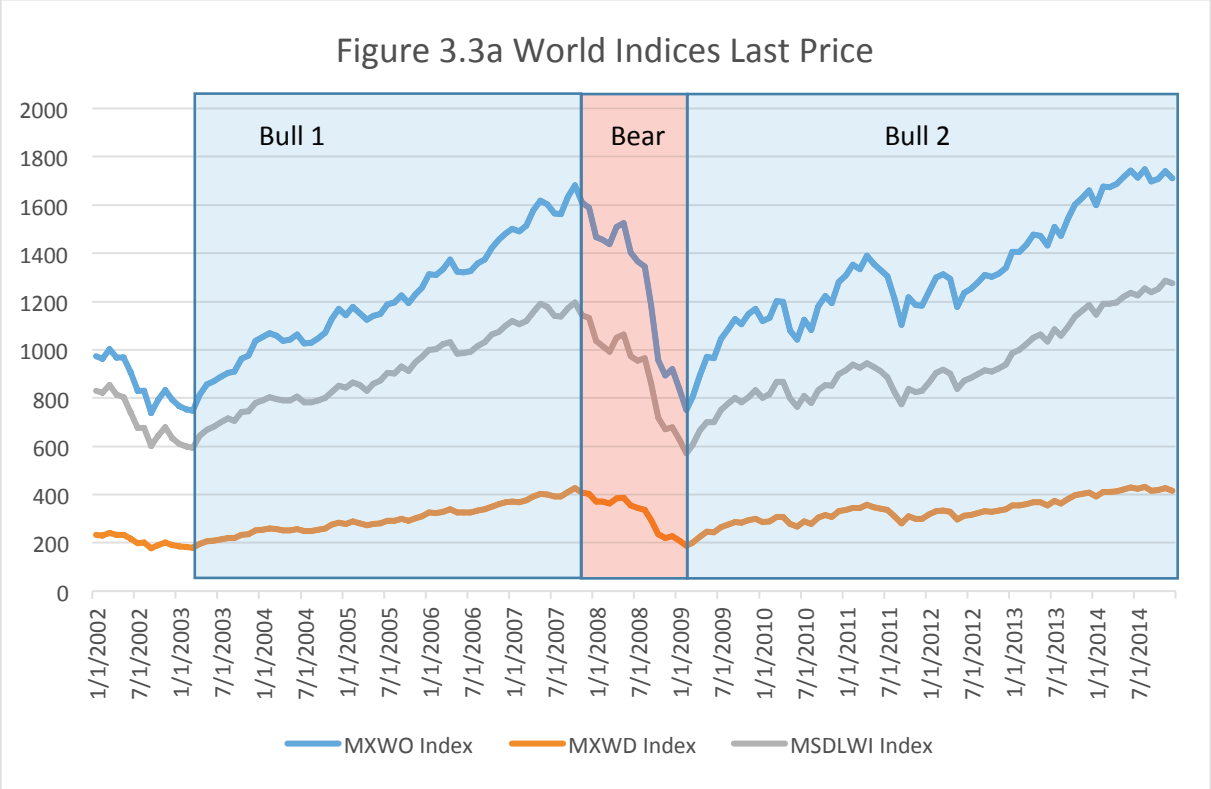
By examining Figure 3.3a the MSCI World index; MSCI ACWI index and MSCI World Local indices can be compared on monthly data since 2002. It is standard practice to use equity indices since investors traditionally use them to check the overall health of the global financial market. Additionally equities normally make up the majority of a portfolio, hence when equities are in a Bear market, it is likely a large number of investors will rebalance portfolios, and it will be important to see if cross-asset correlations change.

All data was taken from Boomberg; the index descriptions are given below:

MSCI world index: MXWO: The MSCI World Index is a free-float weighted equity index. It was developed with a base value of 100 as of December 31, 1969. MXWO includes developed world markets, and does not include emerging markets.

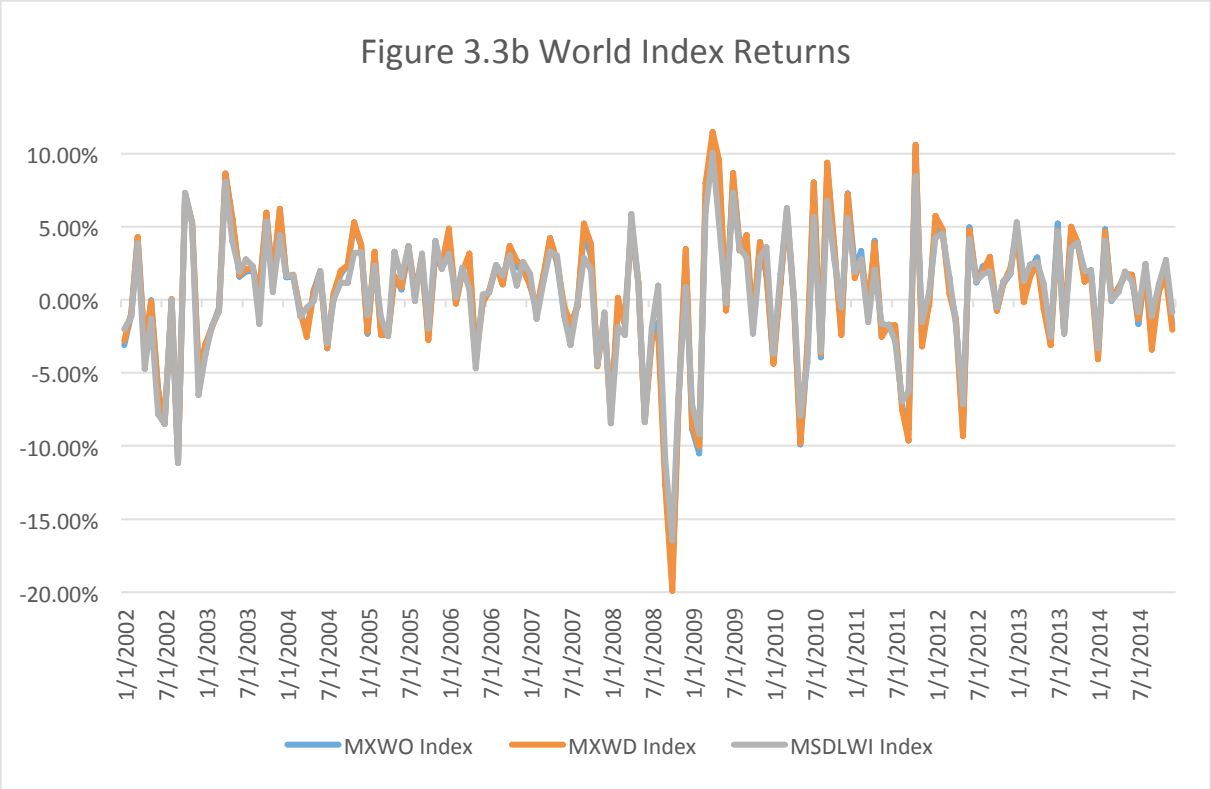
MSCI ACWI: MXWD: The MSCI ACWI Index is a free-float weighted equity index. It was developed with a base value of 100 as of December 31 1987. MXWD includes both emerging and developed world markets.

MSCI World Local: MSDLWI: The MSCI World Local Index is a free-float equity index. MSDLWI includes both emerging and developed world markets; hedged in local currency.



By taking into account these three indices, the global picture of the market can be gathered. Additionally looking at the index returns in Figure 3.3b all three indices move very closely together justifying the use of any to give an overall picture of Global financial health.

A Bull market is a sustained period of price growth and a Bear market is a sustained period of price falls. Therefore separating Bear and Bull markets on Figure 3.3a its clear there are two Bear markets and one Bull market to consider. The first Bull market runs from 31/3/2003 until 31/10/2007; the Bear market 31/10/2007 until 27/2/2009 and the final Bull market 27/2/2009 until 31/12/2014 are highlighted on the graph. These periods will also serve to understand the possible impact of the global financial crisis which hit its peak during 2008.



3.4 ETF Selection

Considering the large ETF universe that currently exists, it is important to be careful to choose ETFs that properly represent the asset class desired. For instance, some ETFs are leveraged to provide twice the return of an underlying index. Others operate under different rules such as using derivatives to replicate returns or lending out securities to recoup management costs; in both of these scenarios the ETF can have greater risk than the underlying asset it is attempting to represent as discussed in Section 2.3. The qualities of each ETF chosen will be listed in Section 3.7. Where possible ETFs will be chosen which do not use derivatives, are unleveraged and do not lend securities. It is very likely that most ETFs will fail one or more of these criteria, especially since many ETFs lend out their component securities to reduce management fees and expenses in an attempt to attract investors over competing ETFs with the same benchmark.

Another point is that some asset classes of ETFs use derivatives to follow index returns; for instance Currency 'carry' or 'Bull' ETFs or Commodity ETFs

often use derivatives. In these cases the ETFs will be selected anyway in the interests of furthering analysis.

The target index should be a Total Return index that includes returns that would have been made by reinvesting cash dividends. Otherwise using the index returns will necessarily underestimate the returns made by the ETF. In the case of missing data this could lead to a large cumulative return differences over time between the index and ETF.

Additionally the expense ratio of ETFs can vary hugely between assets and markets as will be seen in the data; this can clearly impact on returns and should be noted in order to understand if large gains would have been realised or eroded in costs.

Finally the price tracking error is important to understand since it is a measure of how well an ETF can follow price changes in its underlying index. Illiquid or large granular assets such as Private Equity or REITs are likely to have this problem depending on the replication strategy. ETFs with a large price-tracking error are considered inferior since investors may have to wait to buy or sell to obtain the correct price for the underlying asset. ETFs with a consistent large pricing tracking error in one direction can make larger returns or losses than the index; these ETFs are to be avoided since the larger returns may be a result of risky practices resulting is larger returns which are risk-inefficient over the long term.

ETFs chosen should satisfy the criteria that their only goal is to accurately follow the target benchmark, with no counter incentives such as lending out stocks to reduce running costs and plump the manager's salary. For example excessive stock lending can lead to increased counterparty and collateral risk which in turn can destabilise the ETF and increase risk to the investor.

3.5 Calculations

Data was downloaded through Bloomberg into Excel, where weekly returns including dividends will be calculated using the following formula:

$$Weekly\ Return = \frac{(price_{t=2} - price_{t=1} + dividend_{t=2})}{price_{t=1}}$$

Once a spreadsheet for the weekly returns for the Overall, Bull1, Bear and Bull2 market periods has been constructed, it will be imported into EViews.

EViews will calculate the correlations, t-statistics and p-values along with the descriptive statistics. Once all calculations have been completed the results will be downloaded into Excel to construct relevant graphs and the final correlation matrices.

3.6 Correlation Analysis

Correlations calculated will be Pearsons correlations and not spearmans rank correlation. Pearsons correlation is much more descriptive in that it gives the degree one variable increases given a unitary increase in another variable (it is the coefficient of a simple regression). Spearmans rank is a measurement of association and will only give an idea if one variable increases will the other variable increase/decrease/remain unchanged. In either case if a correlation is found, no causation can be implied, more investigation must be conducted to gather evidence for such a conclusion.

Pearsons correlation gives a measure of linear correlation and can hide non-linear relationships or be heavily influenced by outliers therefore the data must be analysed graphically to check the returned correlation seems reasonable and not hiding a different result.

3.7 ETFs Chosen

Data for some of these markets will be limited, either owing to their infancy or simply that the ETF or corresponding asset indexes have not been constructed yet. Index data will be used instead, where possible, and incomplete markets will still be included to see if correlation patterns still persist. The details for ETFs chosen in each market are laid out in the following subsections. All data and descriptions taken from Bloomberg August 2015. Each table includes a description of the ETF and its underlying index, along with inception date, expense ratio, tracking error and market capitalisation. Some brief data is given on each ETF's structure, including replication strategy, if derivatives or leverage are used and if securities are leant out.

3.7.1 U.S. market

The ETFs chosen for the U.S. market along with details and descriptions are shown in Table 3.7.1a below. The U.S. market had the most complete data of all the markets, allowing for complete weekly return data for all assets over the whole time period.

For Broad Market, Fixed Income, Private Equity, Commodity and Currency index data was used to supplement actual ETF returns.

The U.S. asset return correlations results and analysis are explained in section 4.1.

Table 3.7.1a U.S. ETF Descriptions

U.S.	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	iShares Russell 2000 ETF	IWM US	The ETF holds mid and small-cap U.S. stocks. Its investments are in the smallest 2000 companies from the Russell 3000 Index. The ETF weights the holdings by market capitalization; rebalanced annually.	2000	0.20%	0.55	No	No	Full	Yes	USD 26.91B
Large cap	SPDR S&P 500 ETF TRUST	SPY US	Holds predominantly large-cap U.S. stocks. This ETF is structured as a Unit Investment Trust and pays dividends on a quarterly basis; holdings weighted by market cap.	1993	0.10%	0.31	No	No	Full	No	USD 178.66B
Broad Market	Schwab US Broad Market ETF	SCHB US	Schwab U.S. Broad Market ETF is an exchange-traded fund incorporated in the USA. The Fund's goal is to track as closely as possible the total return of the Dow Jones U.S. Broad Stock Market Index.	2009	0.04%	0.35	No	No	Optimised	Yes	USD 5.03B
Fixed Income/ Bonds	ISHARES CORE U.S. AGGREGATE	AGG US	iShares Core U.S. Aggregate Bond ETF is an exchange-traded fund incorporated in the USA. The ETF seeks to track the investment results of an index composed of the total U.S. investment-grade bond market.	2003	0.08%	0.63	No	No	Optimised	Yes	USD 25.76B
REIT	SPDR DOW JONES REIT ETF	RWR US	The Fund's objective seeks to replicate the performance of the DJ US Select REIT Index. Investment in all of the REITs comprising the Index in proportion to their weightings in the Index.	2001	0.25%	0.36	No	No	Optimised	Yes	USD 3.05B
Private Equity	PROSHARES GLOBAL LISTED PRIV	PEX US	The Fund seeks daily investment results that correspond to the daily performance of the LPX Direct Listed Private Equity Index which consists of up to 30 listed private equity companies.	2013	3.13%	6.75	No	No	Full	N/A	USD 15.65
Commodity	UNITED STATES COMMODITY INDEX	USCI US	USCI is an ETF and a Delaware statutory trust, incorporated in the USA. Tracks the investment performance of the SummerHaven Dynamic Commodity Index-Total Return.	2011	0.99%	1.38	No	Yes	Derivatives	No	USD 534.60M
Currency	ETFS BULL USD V G10 BASKET	LUSB LN	Providing investors with a long exposure to the USD relative to a basket of G10 currencies by tracking the MSFXSM Diversified Dollar Long Basket Index (USD) (TR).	2014	0.49%	0.93	No	Yes	Derivatives	No	USD 64.71k

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Table 3.7.1a U.S. ETF Descriptions

U.S.	Index	Ticker	Description
Small Cap	Russell 2000 Index	RU20INTR	The Russell 2000 Index measures the performance of the small-cap segment of the U.S. equity universe. The Russell 2000 is constructed to provide a comprehensive and unbiased small-cap barometer and is completely reconstituted annually to ensure characteristics of the true small-cap opportunity set.
Large cap	S&P 500 Index	SPX	Standard and Poor's 500 Index is a capitalization-weighted index of 500 stocks. The index was developed with a base level of 10 for the 1941-43 base period.
Broad Market	Dow Jones U.S. Broad Stock Market Index	DW25T	The index includes the largest 2,500 publicly traded U.S. companies for which pricing information is readily available. The index is a float-adjusted market capitalization weighted index that reflects the shares of securities actually available to investors in the marketplace.
Fixed Income/ Bonds	Barclays US Agg Total Return Value Unhedged USD	LBUSTRUU	USD denominated investment grade fixed rate bonds, including Treasuries, government-related, securitised and corporte securities. Only bonds with a minimum remaining time to maturity of 1 year are considered for inclusion in the index.
REIT	Dow Jones US Select REIT Total Return Index	DWRTFT	The index measures U.S. REITs and REIT-like securities. It screens for market cap, liquidity and % of revenue derived from ownership and operation of real estate securities. It is float market cap weighted. It is calculated with dividends reinvested and is quoted in USD.
Private Equity	LPX Direct Listed Private Equity Index	LPXDITU	Represents the most actively traded LPE companies that persue a direct private equity investment strategy. Total Return index.
Commodity	SummerHaven Dynamic Commodity Index-Total Return	SDCITR	Tracks the performance of a fully collateralized portfolio of 14 commodity futures, selected each month from a universe of 27 eligible commodities based on observable price signals, subject to a diversification requirement across major commodity sectors.
Currency	Diversified Dollar Long Basket Index (USD) (TR)	MSCEUSLU	

3.7.2 Overall Global Market

The ETFs chosen for the Global Market along with details and descriptions are shown in Table 3.7.2a below. The Global Market had good data coverage for the selected assets, except for Private Equity (where the data starts 3/11/2006).

There is no Currency asset in the Global Market since for all other markets 'currency' has been defined as a bullish view on the countries currency. Since no global currency exists this asset has been left out of the Global Market.

For Small Cap, Large Cap, Broad Market, REIT and Commodity and index data was used to supplement actual ETF returns.

The Global asset return correlations results and analysis are explained in section 4.2.

Table 3.7.2a Global ETF Descriptions

Global	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	SPDR MSCI WORLD SMALL CAP	ZPRS GR	The fund's objective is to track the performance of small cap equities in developed markets globally.	2014	0.45%	3.86	No	No	Optimised	No	EUR 35.55M
Large cap	ISHARES MSCI WORLD ETF	URTH US	iShares MSCI World ETF is an exchange-traded fund incorporated in the USA. The ETF seeks to track the performance results of the MSCI World Index.	2013	0.24%	2.85	No	No	Full	Yes	USD 237.33M
Broad Market	ISHARES MSCI ACWI ETF	ACWI US	The ETF seeks investment results that correspond to the performance of the MSCI ACWI Index.	2008	0.33%	2.12	No	No	Full	Yes	USD 6.25B
Fixed Income/ Bonds	ISHARES IBOXX INVESTMENT GRADE	LQD US	The ETF seeks to track the investment results of an index composed of U.S. dollar-denominated, investment-grade corporate bonds.	2003	0.15%	1.7	No	No	Optimised	Yes	USD 21.02B
REIT	ISHARES GLOBAL REAL ESTATE INDEX	CGR CN	The Fund has been designed to replicate the performance of the Cohen & Steers Global Realty Majors Index.	2008	0.72%	3.85	No	No	Optimised	Yes	CAD 119.49M
Private Equity	POWERSHARES GLB LIST PRIV EQUITY	PSP US	The Fund seeks investment results that correspond generally to the Global Listed Private Equity Index. The constituents of the fund are weighted using a proprietary methodology that is rebalanced quarterly.	2007	2.05%	2.79	No	No	Full	Yes	USD 478.81M
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26M
Currency											

Table 3.7.2a Global ETF Descriptions

Global	Index	Ticker	Description
Small Cap	MSCI Daily TR Net Small Cap World USD	NCUDWI	Provide an exhaustive representation of the small cap size segment, targeting companies in the Investable Market Index but not in the Standard Index in each market.
Large cap	MSCI Daily TR Net World USD	NDDUWI	
Broad Market	MSCI AC World Daily TR Net USD	NDUEACWF	
Fixed Income/ Bonds	Bloomberg Global Investment Grade Corporate Bond Index	BCOR	A rules-based, market-value weighted index engineered to measure investment grade, fixed-rate securities publicly issued in major domestic and euro-bond markets.
REIT	Cohen and Steers Global Realty Majors Portfolio Index	GRM	Cohen and Steers Global Realty Majors Portfolio Index Total Return.
Private Equity	Red Rocks Global Listed Private Equity Index (USD) (TR)	GLPEXUTR	Tracks the performance of global Listed Private Equity companies. The Index is comprised of 40 to 60 global publicly traded companies which invest in, lend to, or provide services to privately held companies.
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency			

3.7.3 UK Market

The ETFs chosen for the UK market along with details and descriptions are shown in Table 3.7.3a below. The UK market had good data coverage for all selected assets, except for REIT (where the data starts 5/1/2007).

For all assets index data was used until ETF data became available. In the case of Private Equity a suitable ETF could not be found and a total return Private Equity index was used for the whole time period.

The UK asset return correlations results and analysis are explained in section 4.3.

Table 3.7.3a UK ETF Descriptions

UK	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI UK SMALL CAP	CUKS LN	The investment objective is to deliver the performance of the MSCI UK Small Cap Index. The investment objective is achieved via a direct replication methodology.	2010	0.58%	2.69	No	No	Optimised	No	GBP 63.95M
Large cap	ISHARES MSCI UK LARGE CAP	CUKL LN	The investment objective is to deliver the performance of the MSCI UK Large Cap Index, less fees and expenses of the Fund. The investment objective is achieved via a direct replication methodology.	2010	0.48%	1.3	No	No	Full	No	GBP 12.57M
Broad Market	SPDR FTSE UK ALL SHARE ETF	FTAL LN	The fund's objective is to track the performance of FTSE All Share Index. The Fund invests in physical securities in the index.	2012	0.20%	1.79	No	No	Optimised	No	GBP 175.26M
Fixed Income/ Bonds	SPDR UK GILT ETF	GLTY LN	The fund's objective is to track the performance of the UK Government bond Gilt market, as represented by the Barclays Capital UK Gilt Index.	2012	0.15%	1.03	No	No	Full	No	GBP 133.64M
REIT	ISHARES UK PROPERTY	IUKP LN	The Fund aims to track the performance of the FTSE EPRA/NAREIT UK Index. The FTSE EPRA/NAREIT UK Index offers exposure to UK listed real estate companies and Real Estate Investment Trusts (REITS).	2007	0.40%	2.59	No	No	Full	Yes	GBP 891.20M
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26M
Currency	ETFS BULL GBP V G10 BASKET	LGBB LN	The product is designed to provide investors with a long exposure to the British Pound relative to a basket of G10 currencies by tracking the MSFXSM Diversified GBP Long Basket Index (GBP) (TR) (the "Index").	2014	0.49%	0.88	#227	Yes	Derivatives	No	GBP 6.22k

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Table 3.7.3a UK ETF Descriptions

UK	Index	Ticker	Description
Small Cap	MSCI Daily TR Net Small Cap UK Local	NCLDUK	Equity index of securities with a small market capitalisation incorporated in the United Kingdom
Large cap	MSCI United Kingdom Large Cap Loc Net	MLCLUKGN	The index offers exposure to equity securities from larger companies in the United Kingdom.
Broad Market	FTSE UK Series FTSE All Share TR	FTPTTALL	The FTSE All-Share Index is a capitalization-weighted index comprising of the FTSE 350 and the FTSE SmallCap Indices.
Fixed Income/ Bonds	Barclays Sterling Gilts Total Return Index Value Unhedged GBP	LSG1TRGU	Barclays Sterling Gilts Total Return Index Value Unhedged GBP
REIT	FTSE EPRA/NAREIT UK Net TR Index GBP	TELUKNG	Designed to track the performance of real estate companies and REITS listed on the London Stock Exchange.
Private Equity	LPX UK Listed Private Equity Index TR	LPXIUKTR	The LPX UK contains all major private equity companies listed on the London stock exchange. It is designed and calculated by LPX Group, a leading listed alternatives research and investment advisory company.
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency	Diversified GBP Long Basket Index (GBP) (TR)	MSCEGBLG	Gives investors a positive exposure to the British Pound relative to a basket of G10 currency pairs.

3.7.4 Europe

The ETFs chosen for the European market along with details and descriptions are shown in Table 3.7.4a below. The European market had good data coverage for all selected assets, except for Small Cap (where the data starts 30/11/2007).

For all assets index data was used until ETF data became available, apart from Broad Market where ETF data was used for the whole time period.

The European asset return correlations results and analysis are explained in section 4.4.

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Table 3.7.4a Europe ETF Descriptions

Europe	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI EUROPE SMALL-CA	IEUS US	The Fund seeks to track the investment results of an index composed of small-capitalization developed market equities in Europe.	2007	0.40%	3.91	No	No	Full	Yes	USD 55.03M
Large cap	ISHARES STOXXEURLARGE200 DE	LCXPEX GR	The fund aims to track the performance of the STOXX Europe Large 200 index.	2005	0.20%	3.97	No	No	Full	Yes	EUR 58.12M
Broad Market	ISHARES MSCI EUROZONE ETF	EZU US	The ETF's objective is to provide investment results of publicly traded security in the European Monetary Union markets, as measured by the MSCI EMU Index.	2000	0.50%	4.47	No	No	Full	Yes	USD 11.09B
Fixed Income/ Bonds	ISHARES EURO AGGREGATE BND	SEAG LN	iShares Euro Aggregate Bond UCITS ETF is an open-end, UCITS compliant exchange traded fund incorporated in Ireland. The Fund aims to track the performance of the Barclays Euro Aggregate Bond Index.	2009	0.25%	1.16	No	No	Full	No	GBP 1.29B
REIT											
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26M
Currency	ETFS BULL EUR V G10 BASKET	LEUB GR	The product is designed to provide investors with a long exposure to the Euro relative to a basket of G10 currencies by tracking the MSFXSM Diversified EUR Long Basket Index (EUR) (TR) (the "Index").	2014	0.49%	N.A.	No	Yes	Derivatives	No	EUR 8.65k

Table 3.7.4a Europe ETF Descriptions

Europe	Index	Ticker	Description
Small Cap	MSCI EUROPE SC NET	M1EUSC	The MSCI Europe Small Cap USD Net index
Large cap	STOXX Europe Large 200 Net Return EUR	LCXR	STOXX Europe Large 200 Net Return EUR
Broad Market	MSCI Daily TR Net EMU	NDDUEMU	Morgan Stanley Capital International Equity Indices in US Dollars. Total Return
Fixed Income/ Bonds	Barclays EuroAgg Total Return Index Value Unhedged EUR	LBEATREU	Barclays EuroAgg Total Return Index Value Unhedged EUR
REIT	MSCI Europe Real Estate Index	MXEU0RE	The MSCI Europe/Real Estate Index is a free-float weighted equity index. It was developed with a base value of 100 as of December 31, 1998.
Private Equity	LPX Europe Listed Private Equity Index TR	LPXEURTR	The LPX Europe contains all major private equity companies listed on European stock exchanges, and is designed and calculated by LPX Group.
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency	Diversified EUR Long Basket Index (EUR) (TR)	MSCEERLE	Designed to provide investors with a long exposure to the Euro relative to a basket of G10 currencies.

3.7.5 Australia

The ETFs chosen for the Australian market along with details and descriptions are shown in Table 3.7.5a below. The Australian market had good data coverage for all selected assets, apart from Fixed Income/Bonds where the data starts at 8/1/2010 and only suitable index data could be found.

For all assets index data was used until ETF data became available, apart from Broad Market where ETF data was used for the whole time period.

The Australian asset return correlations results and analysis are explained in section 4.5.

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Table 3.7.5a Australia ETF Descriptions

Australia	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI AUSTRALIA SMALL	EWAS US	The ETF seeks investment results that correspond generally to the price and yield performance, before fees and expenses, of the MSCI Australia Small Cap Index.	2012	0.59%	9.75	No	No	Full	Yes	USD 2.32M
Large cap											
Broad Market	ISHARES MSCI AUSTRALIA ETF	EWA US	The ETF tracks the performance of the MSCI Australia Index. The ETF holds predominantly large-cap stocks from Australian companies. The ETF weights the holdings using a market capitalization methodology and rebalances quarterly.	1996	0.51%	6.87	No	No	Full	Yes	USD 1.37B
Fixed Income/ Bonds											
REIT	VANGUARD AU PROP SEC IDX ETF	VAP AU	The Fund seeks to match the return (income and capital appreciation) of the S&P/ASX 300 A_REIT Index before taking into account fund fees and expenses.	2010	0.25%	2.78	No	No	Full	No	AUD 432.66M
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26M
Currency											

Table 3.7.5a Australia ETF Descriptions

Australia	Index	Ticker	Description
Small Cap	MSCI Daily TR Net Small Cap Australia USD	NCUAAS	Designed to reflet the performance of small cap companies in the domestic Australia equity market.
Large cap	MSCI AUSTRALIA LARGE CAP INDEX	MXAULC	The MSCI AUSTRALIA LARGE CAP Index is a free float weighted equity index.
Broad Market	MSCI Daily TR Net Australia USD	NDDUAS	Morgan Stanley Capital International Equity Indices in US Dollars. Indices with net dividends reinvested use the same dividend minus-tax-credit calculations, but subtract withholding taxes retained at the source for foreigners who do not benefit from a double taxation treaty.
Fixed Income/ Bonds	Bloomberg AUD Investment Grade Corporate Bond Index	BAUD	The Bloomberg AUD Investment Grade Corporate Bond Index is a rules-based, market-value weighted index engineered to measure AUD denominated investment grade, fixed-rate securities publicly issued in the Australian bond market. To be included in the index a security must have a minimum par amount of 200MM.
REIT	S&P/ASX 300 A-REIT Index	AS52PROP	The S&P/ASX 300 A-REIT Index is a capitalization weighted index that represents all property trusts in the S&P/ASX 300 Index.
Private Equity			
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency	Benchmark World Carry Excess Return Index in AUD	BFXSW5AE	Designed to isolate the carry component of currency returns while minimising the impact of moves in spot exchange rates. Currency in AUD.

3.7.6 Japan

The ETFs chosen for the Japanese market along with details and descriptions are shown in Table 3.7.6a below. The Japanese market had good data coverage for all selected assets, apart from Fixed Income/Bonds where the data starts at 29/1/2010 and only suitable index data could be found.

For all assets index data was used until ETF data became available, apart from Large Cap and Broad Market where ETF data was used for the whole time period.

The Japan asset return correlations results and analysis are explained in section 4.6.

Table 3.7.6a Japan ETF Descriptions

Japan	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI JAPAN SMALL-CAP	SCJ US	The ETF seeks investment results that correspond to the price and yield of the MSCI Japan Small Cap Index.	2007	0.50%	9.65	No	No	Full	Yes	USD 327.23M
Large cap	ISHARES JAPAN LARGE-CAP ETF	ITF US	The Fund seeks investment results that correspond to the performance of the S&P/Tokyo Stock Price Index. The Fund uses a Representative Sampling strategy. The Index includes 150 highly liquid securities selected from each major sector of the Tokyo market.	2001	0.50%	9.04	No	No	Optimised	Yes	USD 83.46M
Broad Market	ISHARES MSCI JAPAN ETF	EWJ US	The ETF's objective seeks to provide investment results that correspond to the performance of the Japanese market, as measured by the MSCI Japan Index. The ETF invests in a representative sample of index stocks in a variety of sectors using a market cap weighted "portfolio sampling" technique.	1996	0.48%	9.88	No	No	Full	Yes	USD 20.36B
Fixed Income/ Bonds											
REIT	NEXT FUNDS REIT NOMURA ETF	1343 JP	NEXT FUNDS REIT Index ETF is an exchange traded fund incorporated in Japan. The Fund's objective is to provide investment results that correspond to the performance of the TSE REIT index. [FIGI BBG000BWWJW4]	2008	0.32%	3.92	No	No	Full	Yes	JPY 132.47B
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26M
Currency											

Table 3.7.6a Japan ETF Descriptions

Japan	Index	Ticker	Description
Small Cap	MSCI Daily TR Net Small Cap Japan USD	NCUAJN	Start date 12/21/98; Source MSCI BARRA
Large cap	SP Topix Yen USD WM NTR	SPTOPXNW	S&P/TOPIX 150 Net Return USD Index calculated with WM rates. S&P/TOPIX 150 represents the large cap universe for Japan. It includes 150 highly liquid securities from each major sector of the Japanese market.
Broad Market	MSCI Daily TR Net Japan USD	NDDUJN	Morgan Stanley Capital International Equity Indices in US Dollars. Index with net dividends reinvested.
Fixed Income/ Bonds	Bloomberg JPY Investment Grade Corporate Bond Index	BJPY	The Bloomberg JPY Investment Grade Corporate Bond Index is a rules-based, market-value weighted index engineered to measure JPY denominated investment grade, fixed-rate securities publicly issued in the Japanese bond market. To be included in the index a security must have a minimum par amount of 20,000MM.
REIT	Tokyo Stock Exchange REIT Index	TSEREIT	The Tokyo Stock Exchange REIT Index is a capitalization-weighted index of all Real Estate Investment Trusts listed on the Tokyo Stock Exchange, and is calculated using the same methodology as the TOPIX.
Private Equity			
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency			

3.7.7 BRIC (Brazil, Russia, India, China)

These countries have been separated since their markets are still developing on a financial and economic level and hence data is sparse for many assets. BRIC more commonly include South Africa to make BRICS; however data for South Africa was so sparse that the market has been omitted from analysis. Any conclusions gained from the other more developed markets will be checked against any available data from these developing BRIC markets.

3.7.7.1 Brazil

The ETFs chosen for the Brazilian market along with details and descriptions are shown in Table 3.7.7.1a below. The Brazilian market had good data coverage for Small Cap, Broad Market and Commodity asset classes. For Large Cap the data starts 7/5/2004 and for REIT 11/1/2008. No data could be found the Currency asset class.

For all assets index data was used until ETF data became available. Only index data could be found for Large Cap, Broad Market and REIT.

The Brazilian asset return correlations results and analysis are explained in section 4.7.

Table 3.7.7.1a Brazil ETF Descriptions

Brazil	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI BRAZIL SMALL-CA	EWZS US	The ETF seeks to track the performance of the MSCI Brazil Small Cap Index Fund.	2010	0.61%	6.74	No	No	Optimised	Yes	USD 28.58 M
Large cap											
Broad Market											
Fixed Income/ Bonds											
REIT											
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26 M
Currency											

U1432450

Table 3.7.7.1a Brazil ETF Descriptions

Brazil	Index	Ticker	Description
Small Cap	MSCI Brazil Small Cap USD Net	MSLUBRZN	Designed to measure the performance of the small cap segment of the Brazilian market.
Large cap	MSCI Brazil Large Cap	MXBRLC	The MSCI Brazil Large Cap Index is a free float weighted equity index.
Broad Market	Ibovespa Brasil Sao Paulo Stock Exchange Index	IBOV	It is a gross total return index weighted by market value to the free float & is comprised of the most liquid stocks traded on the Sao Paulo Stock Exchange.
Fixed Income/ Bonds			
REIT	BM&FBOVESPA Real Estate Index	IMOBBV	This index measures the behavior of the companies that represent the real estate market, and is comprised of companies whose main activities include real estate construction, management and brokerage services.
Private Equity			
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency			

3.7.7.2 Russia

The ETFs chosen for the Russian market along with details and descriptions are shown in Table 3.7.7.2a below. The Russian market had poor data coverage; no suitable data (index or ETF) could be found for REIT, Private Equity and Currency. Only Commodity had full returns for the whole period under study.

Small Cap data starts 4/1/2008; Large Cap at 13/3/2009 and Broad Market 11/5/2007. Both Small and Large Cap use index data until ETF data became available.

The Russian asset return correlations results and analysis are explained in section 4.7.

U1432450

Table 3.7.7.2a Russia ETF Descriptions

Russia	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	MARKET VECTORS RUSSIA SMALL	RSXJ US	The Fund seeks to replicate as closely as possible, before fees and expenses, the price and yield performance of the Market Vectors Russia Small-Cap Index.	2011	0.67%	12.2	No	No	Full	N/A	USD 37.49M
Large cap											
Broad Market	MARKET VECTORS RUSSIA ETF	RSX US	The Fund seeks investment results that correspond to the price and yield of the Market Vectors Russia TR Index, which tracks publicly traded companies that are domiciled in Russia.	2007	0.62%	12.4	No	No	Full	N/A	USD 1.89B
Fixed Income/ Bonds											
REIT											
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26 M
Currency											

Table 3.7.7.2a Russia ETF Descriptions

Russia	Index	Ticker	Description
Small Cap	Market Vectors Russia Small-Cap Index TR Net	MVRSXJTR	MCap-weighted TR Idx. It covers the most liquid Small-Cap comps in RU that are either incorporated there or derive 50%+ revenues there. Comps must have 1mUSD ADTV, 250k shares / mth and 150+ mUSD Mcap. The Wgt is limited to max. 8% per comp; the index is reviewed quarterly.
Large cap	MSCI Russia Large Cap	MXRULC	The MSCI Russia Large Cap Index is a free float weighted equity index.
Broad Market	Market Vectors Russia Index TR Net	MVRSXTR	MVRSXTR is a cap-weighted TR index. It covers the largest & most liquid comps in RU that are either incorporated there or derive 50%+ revenues there. Comps must have 1m USD ADTV, 250k shares/mth and 150+ mUSD Mcap. The wgt is limited to max. 8% per comp; the index is reviewed quarterly.
Fixed Income/ Bonds			
REIT			
Private Equity			
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency			

3.7.7.3 India

The ETFs chosen for the Indian market along with details and descriptions are shown in Table 3.7.7.3a below. The Indian market had poor data coverage; no suitable data (index or ETF) could be found for REIT, Private Equity and Currency; and very limited data for Fixed Income/Bonds. Small Cap, Broad Market and Commodity had full returns for the whole period under study.

Large Cap data starts 13/3/2009; Fixed Income/Bond data starts 20/12/2013 and for both only index data was available and no suitable ETF could be found. All asset returns use index data until ETF data becomes available.

The Indian asset return correlations results and analysis are explained in section 4.7.

Table 3.7.7.3a India ETF Descriptions

India	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI INDIA SMALL-CAP	SMIN US	The ETF seeks investment results that correspond generally to the price and yield performance, before fees and expenses, of the MSCI India Small Cap Index.	2012	0.74%	7.66	No	No	Optimised	Yes	USD 69.42M
Large cap											
Broad Market	ISHARES MSCI INDIA ETF	INDA US	The ETF seeks investment results that correspond generally to the price and yield performance, before fees and expenses, of the MSCI India Index.	2012	0.67%	7.68	No	No	Full	Yes	USD 3.89B
Fixed Income/ Bonds											
REIT											
Private Equity											
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.6	No	No	Full	Yes	USD 631.26M
Currency											

Table 3.7.7.3a India ETF Descriptions

India	Index	Ticker	Description
Small Cap	MSCI India Small Cap USD Net	MSLUINDN	
Large cap	MSCI India Large Cap	MXINLC	The MSCI India Large Cap Index is a free float weighted equity index.
Broad Market	MSCI Emerging Markets India Net TR(USD)	NDEUSIA	Morgan Stanley Capital International Equity Indices Emerging Markets in US Dollars
Fixed Income/ Bonds	S&P BSE India 10 Year Sovereign Bond Index	SPBDISBT	The S&P BSE India 10 Year Sovereign Bond Index is a rules-based, transparent index that seeks to measure the performance of the 10-year Indian sovereign bond. The bond has a fixed coupon and a remaining maturity of close or equal to 10 years.
REIT			
Private Equity			
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency			

3.7.7.4 China

The ETFs chosen for the Chinese market along with details and descriptions are shown in Table 3.7.7.4a below. The Chinese market had complete data coverage for all assets apart from Private Equity and Currency. Private Equity data starts 4/9/2009 and Currency data starts 14/10/2011.

Fixed Income/Bonds data was all index-based and all other assets use index data until ETF data became available.

The China asset return correlations results and analysis are explained in section 4.7.

Table 3.7.7.4a China ETF Descriptions

China	ETF Name	Ticker	Description	Data from	Management fee	Price Tracking Error	Leverage	Derivatives	Replication Strategy	Securities lending	Market Cap
Small Cap	ISHARES MSCI CHINA SMALL-CAP	ECNS US	The ETF seeks to track the performance of the MSCI China Small Cap Index Fund.	2010	0.61%	8.583	No	No	Optimised	Yes	USD 34.22M
Large cap	ISHARES CHINA LARGE-CAP ETF	FXI US	Tracks the performance of the FTSE China 50 Index, holding large-cap stocks. Invests at least 90% of its assets in the underlying index, weighting holdings using a market capitalization, rebalancing quarterly.	2004	0.74%	10.34	No	No	Full	Yes	USD 6.63B
Broad Market	ISHARES MSCI CHINA ETF	MCHI US	Tracks the performance of the MSCI China Index. The Index is a free float adjusted market cap weighted index, measuring the performance of equity securities in the top 85% in market cap of Chinese equity markets, as represented by the H-Shares, B-Shares, Red Chips, & P-Chips.	2011	0.61%	10.56	No	No	Full	Yes	USD 2.05B
Fixed Income/ Bonds											
REIT	GUGGENHEIM CHINA REAL ESTATE	TAO US	Tracks the performance of the AlphaShares China Real Estate Index. The ETF holds financial stocks of all sizes. Its investments are focused in Hong Kong and Chinese real estate; weighted using a market capitalization.	2007	0.71%	7.647	No	No	Full	Yes	USD 20.64M
Private Equity	PENGHUA SSE PRIVATE-OWNED EN	510070 CH	The Fund seeks investment results that correspond to the SSE Private-owned Enterprises 50 Total Return Index. It invests at least 95% in the members of the index.	2010	n/a	15.09	No	No	Full	No	CNY 113.62M
Commodity	SPDR S&P GL NAT RESOURCES	GNR US	The Fund seeks to track the performance of the S&P Global Natural Resources Index which tracks the global natural resources and commodities businesses.	2010	0.40%	2.602	No	No	Full	Yes	USD 631.26M
Currency	CURRENCYSHARES CHINES RENMIN	FXCH US	The investment objective is for the Shares to reflect the price in USD of the Chinese Renminbi. The Shares represent a cost-effective investment in Chinese Renminbi.	2011	0.40%	n/a	No	No	Full	No	USD 7.72M

Table 3.7.7.4a China ETF Descriptions

China	Index	Ticker	Description
Small Cap	MSCI China Small Cap USD Net	MSLUCHNN	Captures small cap respresentation across China A share securities listed on the Shanghai and Shenzhen exchanges
Large cap	FTSE China 50 Net TR Index	TXIN0UNU	Real-time tradable index comprising 50 of the largest and most liquid Chinese stocks.
Broad Market	MSCI Daily TR Net China USD	NDEUCHF	Morgan Stanley Capital International Equity Indices Emerging Markets in US Dollars
Fixed Income/ Bonds	S&P China Composite Bond Index	SPCBCM	The S&P/CITIC China Bond Index family has been calculated since 2000. The series consists of 5 distinct fixed income indices to track China's government, corporate, inter-bank and convertible bond markets. S&P/CITIC China Bond Indices act as institutional benchmarks for investing in the entire China bond market as well as the broadest array of fixed income sub-strategies.
REIT	AlphaShares CHN RE TR	ACNRET	AlphaShares China Real Estate Index (TR)
Private Equity	SSE Private-owned Enterprises 50 Total Return Index	SSER0049	Start Date 08/25/09; source china securities index co., ltd
Commodity	S&P Global Natural Resources Net Total Return Index	SPGNRUT	90 of the largest publicly-traded companies in natural resources and commodities businesses that meet specific investability requirements, offering investors diversified, liquid and investable equity exposure across 3 primary commodity-related sectors: Agribusiness, Energy, and Metals & Mining.
Currency			

4. Data Analysis

Section 4 contains the risk/return graphs, descriptive statistics and correlation matrices for each market. Risk/return graphs show the overall weekly risk (standard deviation) against return for assets in each market. Descriptive statistics table give information on the mean, standard deviation, skew and kurtosis for each asset overall and in each market period. Correlation matrices display the asset correlations found overall and in each market period. Each market will be looked at in turn, with the relevant tables given at the end of each section. Section 4.8 gives the overarching themes collected and evidence for each hypothesis analysed, including return-correlation heat maps that provide an overview of all asset correlations at a glance.

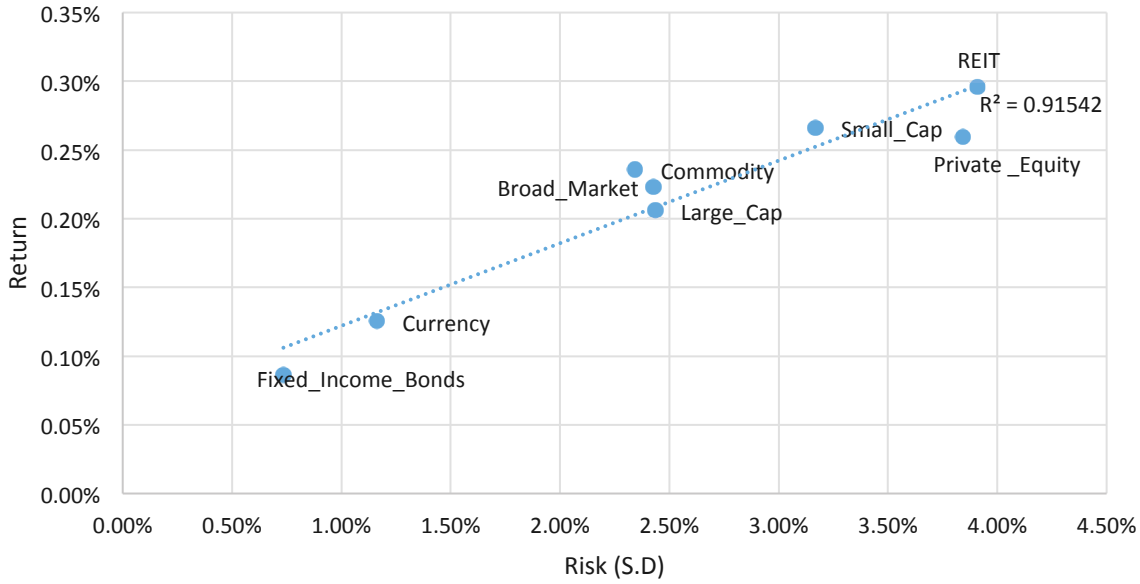
4.1 U.S. Market

The first conclusions will be drawn from the U.S. market since U.S. had the most complete data available. Conclusions drawn from the U.S. data will be compared to the Global and other markets to see if the features of the U.S. market persist. The U.S. Risk/Return graph is given in Figure 4.1a; descriptive data in Table 4.1b and Correlation matrix in Table 4.1c.

4.1.1 Descriptive Statistics

The U.S. descriptive statistics show that REIT was the most lucrative asset class with a 182% return over the time period but at the highest weekly risk (standard deviation) of 3.9%. By examining Figure 4.1a the classical paradigm that higher returns only come along with higher risk rings true.

Figure 4.1a U.S. Weekly Risk and Return



Other than Fixed_Income and Private_Equity weekly returns do not display excessive skew, however all assets display excess kurtosis, evidence of a leptokurtic distribution. The Jarque-Bera and related probability values confirm weekly returns do not follow a normal distribution. Since Pearson's correlation does not assume normality this is not a problem for interpretations made with the correlations found.

Private_Equity, REIT, Small_Cap and Large_Cap all made strong positive returns during Bull markets and large losses during the Bear market.

Fixed_Income was the only asset to make small positive returns in all three market periods, along with the lowest weekly risk of 0.7%.

4.1.2 Correlation Analysis

The first conclusion to be drawn from the data is the strong inter-correlations between Small_Cap; Large_Cap and Broad_Market returns. These correlations are very high (0.89+), highly statistically significant and persist both overall and between the Bull and Bear markets. This is to be expected because Small_Cap and Large_Cap are a subsector of the Broad_Market and all in the

equity asset class and therefore a good indicator that there is not a large mistake in the analysis.

The literature review pointed towards a debate that Small_Cap constitutes a different asset class to Large_Cap. Based on the U.S. Return correlation data, no evidence was found that Small_Cap should be considered a separate asset in terms of its behaviour with other major asset classes. For instance, the correlation between Small_Cap and Commodity overall is 0.373 compared to Large_Cap and Commodity of 0.380. In fact, Small_Cap and Large_Cap have very similar correlations against the other asset classes, with the largest difference against Fixed_Income: Small_Cap 0.009; Large_Cap 0.106. However, this can be discounted since the difference between Small_Cap and Fixed_Income is not statistically significant and both are very close to zero therefore suggesting that no correlation exists.

Furthermore, if the analysis is broken down into the two Bull and single Bear markets, both Small_Cap and Large_Cap follow the same patterns of a strengthening correlation in the Bear market then a weakening correlation in Bull2. This pattern holds against Fixed_Income; REIT; and Private_Equity. Against Commodity both Small_Cap and Large_Cap show a correlation that increases from 0.113/0.098 to 0.503/0.503 from Bull1 to Bull2. Finally the correlations against Currency are broadly similar with the negative correlation increasing in strength from -0.132/-0.152 to -0.270/-0.311 from Bull1 to Bull2.

Therefore, in terms of ETFs Small_Cap and Large_Cap have to be considered near identical against the behaviour of other asset classes in recent Bull and Bear markets and diversification benefits are limited between either sector.

Another feature that emerges from the data is how uncorrelated the Fixed_Income ETF is to the other asset classes; the vast majority of overall correlations are very close to zero or statistically insignificant. This shows that investors are correct in considering bonds a good asset to diversify portfolios since their returns are independent of other asset classes. However

it is important to temper this since during the Bear market there was a statistically robust correlation of 0.446 against Broad_Market and 0.437 against Private_Equity. By definition, negative returns in equities in a Bear market and a positive correlation for Fixed_Income also lead to negative returns. Therefore, at best, the negative returns will only be reduced by diversifying into Fixed_Income and not reversed. A possible reason for the correlation increase in Bear markets is investors fleeing equities while they are in a downward spiral and pursuing a 'flight to quality'. This leads to increased demand for bonds increasing, thereby reducing bond yields and pushing down bond ETF returns. The Bear market Fixed_Income correlation is stronger between Large_Cap (0.474) than Small_Cap (0.346) potentially showing the exodus was stronger from Large Cap equities. This is sensible since Large Caps will make up a larger proportion of the broad equity market and in a Bear market when share prices fall it is likely that Large Caps experienced a larger percentage drop than Small Caps.

REIT return correlations overall are strong against equities and Private_Equity, insignificant against bonds, low against Commodity and weakly negative against Currency. In addition, they follow the same pattern as Fixed_Income where correlation against equities increases from Bull1 to Bear market, then contracts to Bull2. For example, against Broad_Market (0.542 → 0.824 → 0.748). The second Bull2 market has a substantially higher correlation in returns than Bull1. In theory this could be from the financial markets becoming more interconnected or investors seeking greater returns from quantitative easing pushing bond yields downwards. Niskanen and Falkenbach (2010) find very similar REIT correlations in the U.S market, especially against Small Caps.

Private_Equity displays very similar correlations and patterns as REIT but achieves 20% lower cumulative returns overall due to a much larger loss during the Bear market. Additionally Private_Equity has a much larger Price Tracking error and management fee than REIT making an investment choice between the two assets clearly in favour of REIT. Also Private Equity ETFs are generally made up from investing in shares of Private Equity companies

available on the market and therefore may have qualities that more closely follow that of equities rather than a Private Equity fund that directly makes investments.

Commodity correlations strengthen from 2002 to 2014 against all equity types bar Fixed_Income and Currency. Against Fixed_Income they are statistically insignificant and can be considered zero and against Currency there is a negative relationship that deepens in the Bear market.

Currency was modelled by an ETF that represented being bullish on the dollar. Overall returns are correlated weakly negative with every other asset class considered and seem fairly stable between Bull1, Bear and Bull2.

Table 4.1b U.S. ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.27%	0.38%	-0.83%	0.43%	0.21%	0.27%	-0.84%	0.39%
Median	0.37%	0.45%	-0.79%	0.40%	0.31%	0.30%	-0.78%	0.44%
Maximum	16.53%	5.84%	16.53%	11.89%	13.36%	3.64%	13.36%	10.46%
Minimum	-16.32%	-7.88%	-16.32%	-10.52%	-19.75%	-5.43%	-19.75%	-7.11%
Std. Dev.	3.17%	2.41%	5.15%	3.06%	2.44%	1.54%	4.51%	2.28%
Skewness	-0.257	-0.374	0.203	-0.166	-0.701	-0.464	-0.397	0.061
Kurtosis	6.569	3.540	5.121	4.668	12.936	3.795	7.400	5.058
Jarque-Bera	332.61	8.50	13.80	36.73	2576.08	14.93	59.15	53.99
Probability	0.000	0.014	0.001	0.000	0.000	0.001	0.000	0.000
Sum	163.39%	90.36%	-58.77%	130.71%	126.62%	65.20%	-59.78%	119.42%
Sum Sq. Dev.	0.616	0.139	0.186	0.285	0.364	0.056	0.143	0.159
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	0.30%	0.42%	-1.20%	0.53%	0.26%	0.60%	-2.00%	0.50%
Median	0.44%	0.52%	-0.71%	0.49%	0.52%	0.71%	-0.95%	0.46%
Maximum	25.25%	6.39%	25.25%	22.24%	17.95%	4.96%	17.95%	14.88%
Minimum	-19.05%	-9.31%	-19.05%	-12.31%	-29.26%	-8.20%	-29.26%	-15.43%
Std. Dev.	3.91%	2.44%	7.08%	3.78%	3.84%	1.85%	7.10%	3.77%
Skewness	0.204	-0.570	0.404	0.695	-1.338	-0.825	-0.876	-0.172
Kurtosis	11.621	4.354	6.187	9.061	13.832	5.302	6.421	6.504
Jarque-Bera	1905.56	31.33	31.97	491.40	3184.98	80.21	43.71	157.56
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	181.75%	101.42%	-85.03%	160.40%	159.30%	144.01%	-141.75%	153.30%
Sum Sq. Dev.	0.937	0.142	0.351	0.434	0.904	0.082	0.353	0.432
Observations	614	240	71	305	614	240	71	305

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Table 4.1b U.S. ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.22%	0.29%	-0.83%	0.40%	0.09%	0.08%	0.10%	0.09%
Median	0.31%	0.30%	-0.68%	0.44%	0.11%	0.10%	0.25%	0.12%
Maximum	12.13%	3.57%	12.13%	10.83%	6.54%	1.67%	6.54%	1.59%
Minimum	-18.11%	-4.86%	-18.11%	-7.55%	-10.27%	-1.56%	-10.27%	-1.95%
Std. Dev.	2.43%	1.53%	4.34%	2.34%	0.74%	0.51%	1.67%	0.49%
Skewness	-0.621	-0.416	-0.340	-0.004	-3.623	-0.253	-2.625	-0.731
Kurtosis	10.622	3.459	6.401	5.194	75.432	3.252	24.742	4.504
Jarque-Bera	1525.52	9.03	35.59	61.19	135565.00	3.20	1479.99	55.92
Probability	0.000	0.011	0.000	0.000	0.000	0.201	0.000	0.000
Sum	137.06%	70.72%	-58.89%	123.11%	53.07%	19.05%	7.26%	26.68%
Sum Sq. Dev.	0.361	0.056	0.132	0.167	0.033	0.006	0.020	0.007
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.24%	0.57%	-0.26%	0.09%	0.13%	-0.05%	0.95%	0.08%
Median	0.36%	0.82%	0.70%	0.12%	0.04%	-0.09%	1.03%	0.05%
Maximum	6.45%	5.40%	6.45%	4.95%	6.53%	2.80%	6.53%	3.25%
Minimum	-10.93%	-5.43%	-10.93%	-8.55%	-3.64%	-2.14%	-3.64%	-3.35%
Std. Dev.	2.34%	2.03%	3.89%	2.04%	1.16%	0.93%	1.65%	1.12%
Skewness	-0.840	-0.307	-0.894	-0.474	0.634	0.303	0.568	0.089
Kurtosis	5.570	3.011	3.550	4.725	5.125	2.755	4.570	3.218
Jarque-Bera	241.20	3.76	10.36	49.23	156.70	4.26	11.10	1.01
Probability	0.000	0.153	0.006	0.000	0.000	0.119	0.004	0.605
Sum	144.78%	136.93%	-18.12%	27.58%	77.11%	-12.72%	67.67%	24.03%
Sum Sq. Dev.	0.336	0.099	0.106	0.126	0.083	0.021	0.019	0.038
Observations	614	240	71	305	614	240	71	305

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Table 4.1c U.S. ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	1	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.915	0.892	0.923	0.931	1	1	1	1				
	56.185	30.362	19.928	44.300	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.928	0.884	0.938	0.947	0.992	0.987	0.993	0.994	1	1	1	1
	61.588	29.127	22.393	51.496	198.374	95.207	68.067	164.594	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	0.009	-0.197	0.346	-0.298	0.106	-0.155	0.474	-0.302	0.082	-0.172	0.446	-0.293
	0.217	-3.094	3.063	-5.425	2.634	-2.425	4.472	-5.518	2.047	-2.689	4.145	-5.336
	0.828	0.002	0.003	0.000	0.009	0.016	0.000	0.000	0.041	0.008	0.000	0.000
REIT	0.763	0.600	0.891	0.738	0.749	0.563	0.814	0.749	0.748	0.542	0.824	0.748
	29.181	11.559	16.302	19.043	27.935	10.523	11.629	19.685	27.876	9.960	12.075	19.610
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	0.789	0.689	0.855	0.797	0.827	0.722	0.875	0.813	0.823	0.724	0.860	0.817
	31.763	14.661	13.668	22.971	36.371	16.090	15.004	24.347	35.837	16.212	14.029	24.704
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COMMODITY	0.373	0.113	0.407	0.503	0.380	0.098	0.415	0.503	0.374	0.092	0.398	0.502
	9.957	1.759	3.703	10.140	10.170	1.523	3.793	10.138	9.971	1.421	3.604	10.109
	0.000	0.080	0.000	0.000	0.000	0.129	0.000	0.000	0.000	0.157	0.001	0.000
CURRENCY	-0.269	-0.132	-0.333	-0.270	-0.270	-0.152	-0.232	-0.311	-0.274	-0.155	-0.239	-0.309
	-6.903	-2.062	-2.938	-4.872	-6.939	-2.377	-1.982	-5.699	-7.043	-2.423	-2.046	-5.652
	0.000	0.040	0.005	0.000	0.000	0.018	0.051	0.000	0.000	0.016	0.045	0.000

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1	1	1	1												
	-----	-----	-----	-----												
	-----	-----	-----	-----												
REIT	0.038	-0.037	0.169	-0.104	1	1	1	1								
	0.934	-0.578	1.428	-1.824	-----	-----	-----	-----								
	0.351	0.564	0.158	0.069	-----	-----	-----	-----								
PRIVATE_EQUITY	0.137	-0.087	0.437	-0.181	0.685	0.459	0.756	0.676	1	1	1	1				
	3.433	-1.344	4.037	-3.211	23.258	7.971	9.597	15.986	-----	-----	-----	-----				
	0.001	0.180	0.000	0.002	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
COMMODITY	0.037	-0.010	0.192	-0.147	0.314	0.116	0.331	0.398	0.488	0.303	0.536	0.550	1	1	1	1
	0.919	-0.150	1.623	-2.596	8.174	1.807	2.915	7.550	13.822	4.903	5.277	11.456	-----	-----	-----	-----
	0.359	0.881	0.109	0.010	0.000	0.072	0.005	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
CURRENCY	-0.123	-0.247	-0.067	-0.152	-0.268	-0.161	-0.361	-0.224	-0.425	-0.399	-0.376	-0.431	-0.467	-0.362	-0.614	-0.431
	-3.060	-3.928	-0.556	-2.675	-6.877	-2.520	-3.219	-4.002	-11.608	-6.717	-3.367	-8.322	-13.078	-5.986	-6.462	-8.322
	0.002	0.000	0.580	0.008	0.000	0.012	0.002	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000

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4.2 Global Market

The Global Market had good data coverage for all assets other than Private Equity (where data was limited) and currency which doesn't exist since there is no global currency. Data highlighted in red was incomplete and started later than other assets. The Global Risk/Return graph is given in Figure 4.2a; descriptive data in Table 4.2b and Correlation matrix in Table 4.2c.

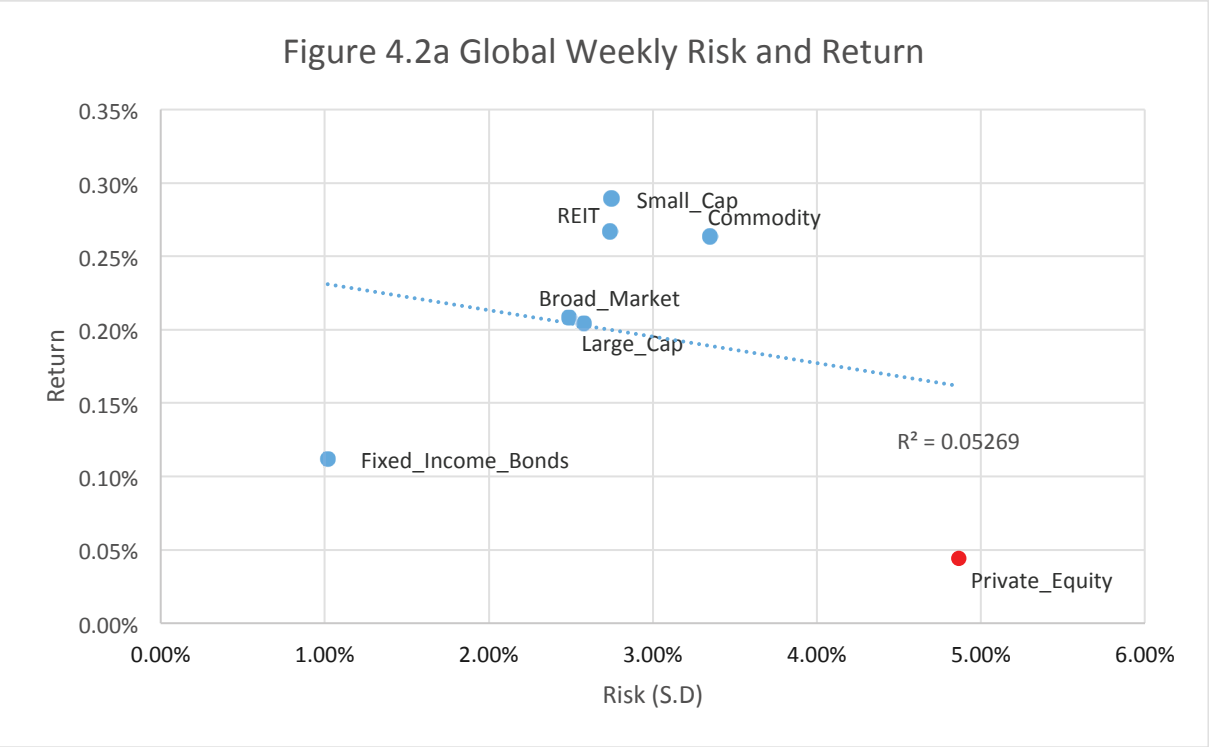
4.2.1 Descriptive Statistics

Global Markets descriptive statistics in Figure 4.2a show all weekly asset returns displayed negative skew overall and significant excess kurtosis, following a leptokurtic distribution. For all assets the Jarque-Bera statistic and related p-value strongly suggest weekly returns do not follow a normal distribution.

All assets made positive returns in Bull markets and negative returns in the Bear market. Fixed_Income was the best store of value in the Bear market with negative weekly returns of -0.05%; additionally had the lowest weekly standard deviation of all assets.

Small_Cap; REIT and Commodity were the most lucrative assets overall with 160-180% returns.

Private_Equity was the most volatile at 4.87% weekly and overall weekly returns were near zero at 0.04%. Private_Equity looks an anomaly on the Risk/Return graph; presenting the most risk at the least return. Removing this result would lead to a much stronger upwards relationship between risk and return.



4.2.2 Correlation Analysis

Figure 4.2c shows the correlation matrix for all assets in the Global market. Between Small_Cap and Large_Cap there are large strong statistically significant positive correlations overall and between the Bull and Bear markets as to be expected. Against Fixed_Income correlations are either very low or statistically insignificant. The correlation does seem to rise during the Bear market and decrease during the second Bull market. This is indicative of a weak positive correlation during Bear markets and an uncorrelated nature during Bull markets.

REITs and equities were more heavily correlated in the first Bull market, then decrease in Bear and Bull2, suggestive of a trend that the two assets are becoming more uncorrelated. Considering the similarity in weekly returns and weekly standard deviation. REITs are a strong candidate for investors to diversify risk and still obtain high returns.

Private_Equity correlations seem steady against equities at around 0.85 overall and in the different market periods, but these results should be taken carefully considering the anomalous nature of Private_Equity on the Risk and Return graph (Figure 4.2a).

Equities and Commodity correlations increase marginally over the period studied starting at around 0.75 and ending around 0.85.

Fixed_Income is noticeably highly uncorrelated with all other assets showing their value as an asset for diversification along with the very low weekly standard deviation.

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Table 4.2b Global ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.29%	0.47%	-1.01%	0.44%	0.21%	0.36%	-0.94%	0.35%
Median	0.57%	0.65%	-0.43%	0.63%	0.41%	0.52%	-0.68%	0.47%
Maximum	12.57%	4.99%	12.57%	8.46%	12.39%	4.03%	12.39%	8.50%
Minimum	-17.96%	-6.32%	-17.96%	-10.67%	-20.03%	-5.27%	-20.03%	-8.52%
Std. Dev.	2.75%	1.95%	4.55%	2.66%	2.49%	1.58%	4.44%	2.39%
Skewness	-0.887	-0.581	-0.467	-0.506	-1.054	-0.482	-0.751	-0.273
Kurtosis	8.241	3.814	5.846	4.785	11.985	3.736	7.501	4.431
Jarque-Bera	783.16	20.13	26.54	53.49	2179.21	14.70	66.61	29.80
Probability	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
Sum	177.72%	113.45%	-71.84%	134.36%	127.98%	85.91%	-66.78%	108.04%
Sum Sq. Dev.	0.463	0.091	0.145	0.215	0.381	0.059	0.138	0.174
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	0.27%	0.54%	-1.05%	0.37%	0.04%	0.10%	-1.82%	0.46%
Median	0.42%	0.76%	-1.08%	0.33%	0.29%	-0.14%	-1.61%	0.53%
Maximum	17.59%	6.49%	17.59%	10.76%	28.64%	5.88%	28.64%	22.72%
Minimum	-18.92%	-7.58%	-18.92%	-10.46%	-28.20%	-8.32%	-28.20%	-18.69%
Std. Dev.	2.74%	2.01%	5.11%	2.35%	4.87%	2.71%	8.45%	3.81%
Skewness	-0.501	-0.691	0.053	0.163	-0.476	-0.553	-0.136	0.346
Kurtosis	11.113	4.856	6.245	5.993	12.173	3.993	5.844	10.465
Jarque-Bera	1709.64	53.52	31.18	115.19	1509.63	4.79	24.15	714.32
Probability	0.000	0.000	0.000	0.000	0.000	0.091	0.000	0.000
Sum	163.95%	130.73%	-74.59%	112.62%	18.80%	5.03%	-129.55%	141.20%
Sum Sq. Dev.	0.460	0.097	0.183	0.167	1.006	0.037	0.500	0.441
Observations	614	240	71	305	426	52	71	305

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Table 4.2b Global ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.20%	0.38%	-0.97%	0.33%	0.11%	0.09%	-0.05%	0.15%
Median	0.41%	0.56%	-0.82%	0.42%	0.17%	0.12%	0.02%	0.24%
Maximum	13.79%	4.12%	13.79%	9.38%	4.58%	2.17%	4.58%	2.78%
Minimum	-18.60%	-5.30%	-18.60%	-8.40%	-7.94%	-2.90%	-7.94%	-3.83%
Std. Dev.	2.58%	1.61%	4.58%	2.50%	1.02%	0.77%	2.00%	0.86%
Skewness	-0.686	-0.505	-0.349	-0.044	-1.337	-0.305	-1.092	-0.771
Kurtosis	7.394	3.816	3.780	1.726	14.483	3.790	7.400	4.956
Jarque-Bera	969.03	16.85	38.72	37.21	3556.45	9.96	71.39	78.82
Probability	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000
Sum	125.32%	91.70%	-68.98%	101.40%	68.78%	22.26%	-3.58%	46.58%
Sum Sq. Dev.	0.471	0.062	0.146	0.192	0.064	0.014	0.028	0.023
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	NA	NA	NA	NA
Median	0.46%	0.91%	-0.36%	0.16%	NA	NA	NA	NA
Maximum	18.06%	6.85%	18.06%	9.29%	NA	NA	NA	NA
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	NA	NA	NA	NA
Std. Dev.	3.35%	2.46%	6.10%	3.01%	NA	NA	NA	NA
Skewness	-0.459	-0.581	-0.079	-0.177	NA	NA	NA	NA
Kurtosis	9.262	3.874	5.726	4.724	NA	NA	NA	NA
Jarque-Bera	1024.73	21.12	22.06	39.35	NA	NA	NA	NA
Probability	0.000	0.000	0.000	0.000	NA	NA	NA	NA
Sum	161.87%	154.51%	-40.82%	47.25%	NA	NA	NA	NA
Sum Sq. Dev.	0.688	0.145	0.261	0.275	NA	NA	NA	NA
Observations	614	240	71	305	NA	NA	NA	NA

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Table 4.2c Global ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1.000	1.000	1.000	1.000								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.929	0.926	0.975	0.896	1.000	1.000	1.000	1.000				
	61.898	37.708	36.153	35.148	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.952	0.930	0.968	0.951	0.949	0.998	0.979	0.906	1.000	1.000	1.000	1.000
	77.254	38.988	31.853	53.818	74.364	248.653	38.747	37.332	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	0.105	-0.013	0.238	0.042	0.137	-0.031	0.284	0.064	0.089	-0.029	0.215	0.014
	2.620	-0.195	2.033	0.726	3.409	-0.486	2.460	1.115	2.207	-0.448	1.831	0.249
	0.009	0.846	0.046	0.468	0.001	0.628	0.016	0.266	0.029	0.655	0.071	0.803
REIT	0.614	0.760	0.524	0.594	0.577	0.753	0.508	0.538	0.536	0.756	0.446	0.576
	19.220	18.029	5.115	12.861	17.475	17.678	4.895	11.101	17.122	17.813	4.140	12.252
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	0.866	0.778	0.873	0.873	0.842	0.800	0.863	0.824	0.858	0.779	0.833	0.888
	35.620	8.765	14.871	31.166	32.122	9.436	14.166	25.278	34.420	8.780	12.541	33.671
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COMMODITY	0.845	0.720	0.874	0.891	0.839	0.765	0.889	0.839	0.879	0.782	0.896	0.917
	39.065	16.016	14.954	34.176	38.191	18.351	16.119	26.847	45.596	19.365	16.798	40.100
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1.000	1.000	1.000	1.000												
	-----	-----	-----	-----												
	-----	-----	-----	-----												
REIT	0.155	0.090	0.111	0.214	1.000	1.000	1.000	1.000								
	3.869	1.399	0.929	3.808	-----	-----	-----	-----								
	0.000	0.163	0.356	0.000	-----	-----	-----	-----								
PRIVATE_EQUITY	0.093	-0.181	0.139	0.047	0.556	0.774	0.431	0.640	1.000	1.000	1.000	1.000				
	1.920	-1.298	1.168	0.825	13.761	8.645	3.973	14.506	-----	-----	-----	-----				
	0.056	0.200	0.247	0.410	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
COMMODITY	0.076	-0.019	0.197	0.004	0.470	0.567	0.411	0.456	0.732	0.535	0.694	0.804	1.000	1.000	1.000	1.000
	1.874	-0.298	1.671	0.074	13.180	10.617	3.747	8.920	22.148	4.474	8.009	23.557	-----	-----	-----	-----
	0.061	0.766	0.099	0.941	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----

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4.3 UK Market

The UK market had good data coverage for all assets other than REIT. Where returns data was limited for the start of the first Bull market, this data was highlighted in red when incomplete. The UK Risk/Return graph is given in Figure 4.3a, descriptive data in Table 4.3b and Correlation matrix in Table 4.3c.

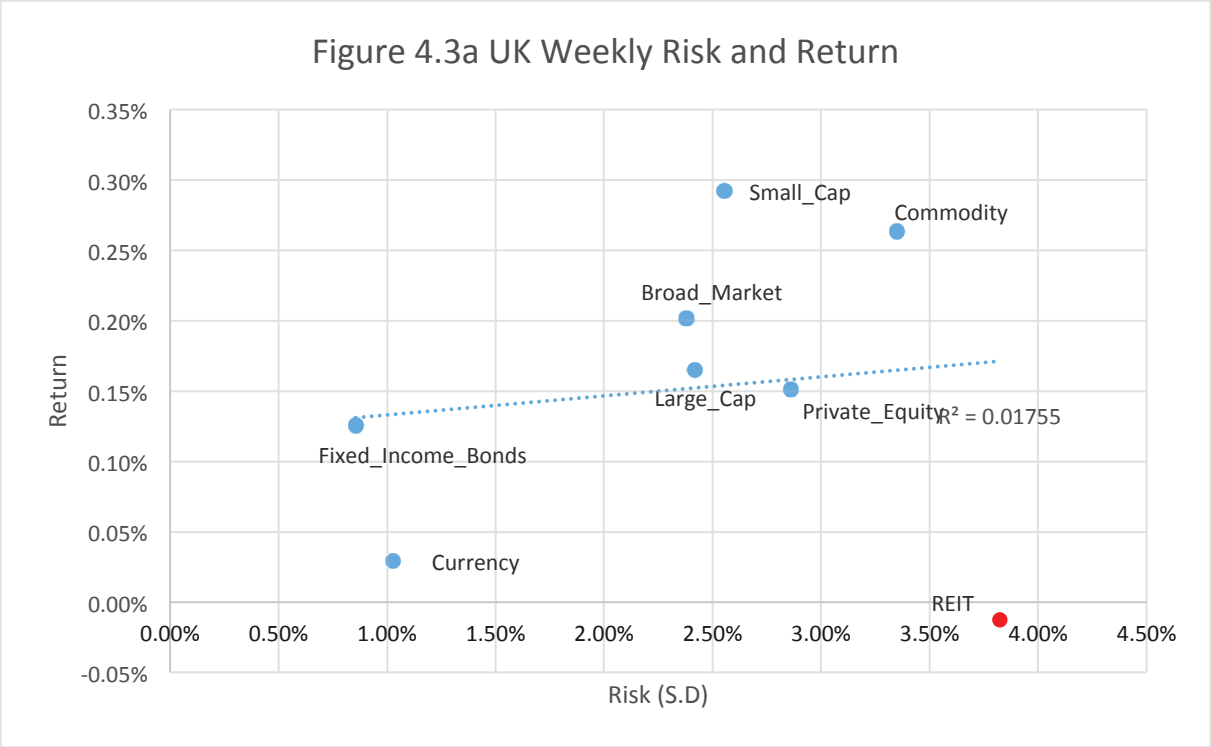
4.3.1 Descriptive Statistics

Descriptive data for all assets is laid out in Figure 4.3b; all assets (other than Fixed_Income) display negative skew and excess kurtosis showing a leptokurtic distribution. Additionally the Jarque-Bera statistics are high and related p-value strongly suggest UK asset weekly returns do not follow normal distributions.

Bar Fixed_Income and REITs all other assets make positive returns in Bull markets and negative in Bear. Fixed_Income had the lowest risk with a weekly standard deviation of 0.86% overall and was the only asset to make positive returns in the Bear market.

Small_Cap was the most lucrative asset with 179% returns overall, additionally compared to Large_Cap the weekly standard deviations are similar (2.55% against 2.42%) and Large_Cap only achieves 101% overall.

REIT had the highest weekly volatility at 3.82% with overall weekly returns near zero at -0.01%. As in the Global market with Private _Equity, UK REIT looks an anomaly on the Risk/Risk graph Figure 4.3a and removing would lead to a much stronger positive relationship between risk and return.



4.3.2 Correlation Analysis

Figure 4.3c shows the correlation matrix for all assets in the UK market. Small_Cap and Large_Cap correlations increase from Bull1 to Bear to become strong at 0.83. Against Fixed_Income correlations are weakly negative and statistically insignificant during the Bear market and seem strongly negative during the Bull2 market. Against Commodities, the correlation increases over time, strengthening through Bull1, Bear and Bull2 markets.

REITs display correlations of roughly 0.7 against most assets, -0.228 against Fixed_Income and 0.230 against Currency. However considering the data was limited and it's anomalous nature on Figure 4.3a, these results cannot hold much weight.

Private_Equity correlations are midway positive against all assets and in all time periods apart from against Fixed_Income. Additionally against other assets correlations increase during Bear markets and decrease during Bull markets, especially against equities.

Fixed_Income and Currency have noticeably weaker correlations with all other assets in both Bear and Bull markets, showing that these assets can be considered dependent on differing factors to other assets.

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Table 4.3b UK ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.29%	0.48%	-0.81%	0.41%	0.17%	0.28%	-0.54%	0.24%
Median	0.62%	0.72%	-0.46%	0.64%	0.20%	0.32%	-0.72%	0.24%
Maximum	9.51%	5.43%	9.51%	8.10%	13.42%	4.25%	13.42%	7.19%
Minimum	-15.09%	-6.47%	-15.09%	-11.72%	-21.52%	-5.51%	-21.52%	-9.10%
Std. Dev.	2.55%	1.87%	4.22%	2.44%	2.42%	1.54%	4.68%	2.18%
Skewness	-0.864	-0.698	-0.395	-0.574	-1.013	-0.375	-0.636	-0.355
Kurtosis	6.720	4.366	4.063	5.215	16.939	3.600	8.922	5.167
Jarque-Bera	430.25	38.15	5.18	79.11	5075.53	9.22	108.52	66.11
Probability	0.000	0.000	0.075	0.000	0.000	0.010	0.000	0.000
Sum	179.48%	114.16%	-57.23%	125.14%	101.33%	67.46%	-38.62%	72.81%
Sum Sq. Dev.	0.400	0.084	0.125	0.181	0.358	0.057	0.154	0.145
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	-0.01%	-0.79%	-1.30%	0.43%	0.15%	0.39%	-2.11%	0.46%
Median	0.09%	-0.94%	-0.91%	0.34%	0.35%	0.44%	-1.68%	0.44%
Maximum	17.75%	5.30%	17.75%	13.46%	15.47%	4.49%	11.29%	15.47%
Minimum	-18.63%	-8.27%	-18.63%	-13.38%	-22.74%	-6.74%	-22.74%	-11.45%
Std. Dev.	3.82%	3.25%	6.20%	3.05%	2.86%	1.53%	5.45%	2.60%
Skewness	-0.705	-0.340	-0.444	-0.003	-1.397	-0.578	-1.060	0.809
Kurtosis	8.231	3.000	4.651	6.776	17.075	5.018	6.020	10.972
Jarque-Bera	510.09	0.83	10.40	181.20	5267.88	54.08	40.27	840.91
Probability	0.000	0.660	0.006	0.000	0.000	0.000	0.000	0.000
Sum	-5.22%	-34.01%	-92.42%	130.34%	92.97%	93.12%	-150.15%	140.95%
Sum Sq. Dev.	0.608	0.044	0.269	0.282	0.501	0.056	0.208	0.205
Observations	417	43	71	305	614	240	71	305

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Table 4.3b UK ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.20%	0.33%	-0.60%	0.29%	0.13%	0.12%	0.18%	0.12%
Median	0.33%	0.40%	-0.49%	0.39%	0.14%	0.09%	0.26%	0.16%
Maximum	12.92%	4.37%	12.92%	7.41%	4.46%	2.36%	3.00%	4.46%
Minimum	-20.15%	-5.78%	-20.15%	-9.61%	-3.44%	-1.87%	-3.44%	-2.38%
Std. Dev.	2.38%	1.53%	4.47%	2.19%	0.86%	0.70%	1.18%	0.88%
Skewness	-0.996	-0.526	-0.571	-0.438	0.112	0.383	-0.321	0.186
Kurtosis	14.642	4.039	8.319	5.138	4.580	3.964	3.549	4.437
Jarque-Bera	3569.16	21.85	87.55	67.88	65.18	15.15	2.11	28.01
Probability	0.000	0.000	0.000	0.000	0.000	0.001	0.348	0.000
Sum	123.87%	79.41%	-42.50%	87.76%	77.23%	28.05%	12.73%	35.11%
Sum Sq. Dev.	0.347	0.056	0.140	0.146	0.045	0.012	0.010	0.024
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	0.03%	0.14%	-0.31%	0.02%
Median	0.46%	0.91%	-0.36%	0.16%	0.03%	0.11%	-0.19%	0.01%
Maximum	18.06%	6.85%	18.06%	9.29%	6.32%	2.15%	6.32%	2.86%
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	-6.35%	-2.18%	-6.35%	-2.85%
Std. Dev.	3.35%	2.46%	6.10%	3.01%	1.03%	0.77%	2.02%	0.83%
Skewness	-0.459	-0.581	-0.079	-0.177	-0.500	-0.081	-0.142	0.070
Kurtosis	9.262	3.874	5.726	4.724	11.439	3.146	5.823	3.970
Jarque-Bera	1024.73	21.12	22.06	39.35	1847.77	0.47	23.81	12.20
Probability	0.000	0.000	0.000	0.000	0.000	0.789	0.000	0.002
Sum	161.87%	154.51%	-40.82%	47.25%	18.11%	33.79%	-22.29%	5.95%
Sum Sq. Dev.	0.688	0.145	0.261	0.275	0.065	0.014	0.028	0.021
Observations	614	240	71	305	614	240	71	305

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Table 4.3c UK ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	1	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.803	0.675	0.830	0.840	1	1	1	1				
	33.344	14.132	12.365	26.939	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.875	0.798	0.884	0.903	0.986	0.978	0.994	0.980	1	1	1	1
	44.610	20.419	15.678	36.599	144.385	73.099	75.582	86.713	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_BONDS	-0.291	-0.167	-0.123	-0.444	-0.310	-0.238	-0.121	-0.476	-0.322	-0.239	-0.124	-0.491
	-7.517	-2.617	-1.026	-8.626	-8.077	-3.778	-1.009	-9.427	-8.412	-3.798	-1.034	-9.804
	0.000	0.009	0.309	0.000	0.000	0.000	0.317	0.000	0.000	0.000	0.305	0.000
REIT	0.752	0.667	0.759	0.746	0.706	0.691	0.705	0.690	0.744	0.734	0.739	0.731
	23.268	5.737	9.686	19.508	20.287	6.125	8.253	16.579	22.684	6.911	9.108	18.666
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	0.666	0.637	0.696	0.630	0.602	0.441	0.682	0.566	0.638	0.530	0.701	0.598
	22.083	12.765	8.040	14.124	18.655	7.574	7.741	11.950	20.503	9.654	8.166	12.992
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COMMODITY	0.705	0.496	0.747	0.770	0.806	0.618	0.864	0.839	0.813	0.638	0.862	0.847
	24.591	8.818	9.345	21.038	33.717	12.126	14.270	26.815	34.488	12.779	14.139	27.762
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CURRENCY	0.154	0.017	0.325	0.026	0.101	-0.116	0.277	-0.029	0.114	-0.075	0.294	-0.029
	3.859	0.258	2.858	0.454	2.513	-1.802	2.392	-0.509	2.849	-1.160	2.559	-0.498
	0.000	0.796	0.006	0.651	0.012	0.073	0.020	0.611	0.005	0.247	0.013	0.619

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_BONDS	1	1	1	1												
	-----	-----	-----	-----												
	-----	-----	-----	-----												
REIT	-0.228	-0.246	-0.061	-0.356	1	1	1	1								
	-4.771	-1.623	-0.508	-6.621	-----	-----	-----	-----								
	0.000	0.112	0.613	0.000	-----	-----	-----	-----								
PRIVATE_EQUITY	-0.302	-0.251	-0.245	-0.361	0.623	0.594	0.614	0.559	1	1	1	1				
	-7.825	-3.996	-2.099	-6.737	16.207	4.729	6.455	11.739	-----	-----	-----	-----				
	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
COMMODITY	-0.307	-0.140	-0.222	-0.445	0.583	0.576	0.556	0.601	0.499	0.366	0.576	0.482	1	1	1	1
	-7.984	-2.187	-1.894	-8.656	14.611	4.512	5.559	13.087	14.235	6.061	5.848	9.585	-----	-----	-----	-----
	0.000	0.030	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
CURRENCY	-0.140	-0.120	-0.192	-0.116	0.230	0.137	0.393	0.027	0.498	0.526	0.519	0.446	0.233	0.175	0.361	0.094
	-3.507	-1.858	-1.626	-2.037	4.809	0.883	3.548	0.467	14.208	9.534	5.047	8.675	5.919	2.736	3.217	1.635
	0.001	0.064	0.109	0.043	0.000	0.382	0.001	0.641	0.000	0.000	0.000	0.000	0.000	0.007	0.002	0.103

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4.4 Europe

The Europe market had good data coverage for all assets other than Small_Cap. Where returns data was non-existent for the Bull1 market and limited for the Bear market. Data was highlighted in red when incomplete. The European Risk/Return graph is given in Figure 4.4a descriptive data in Table 4.4b and Correlation matrix in Table 4.4c.

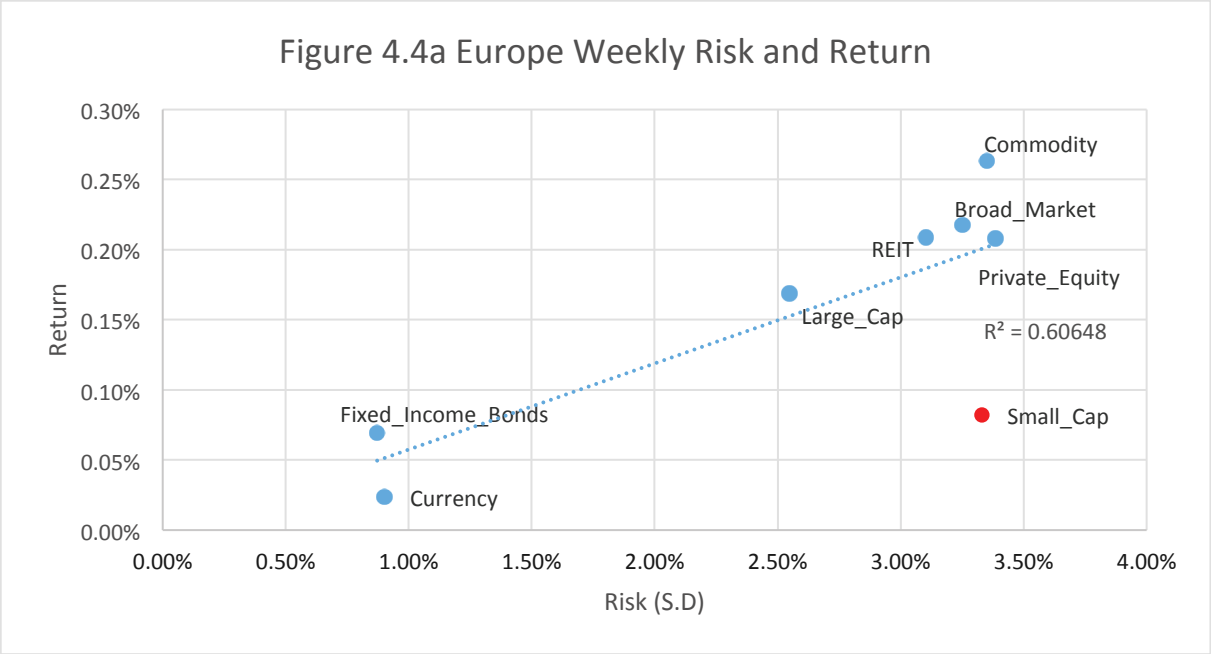
4.4.1 Descriptive Statistics

Descriptive data laid out in Figure 4.4b shows all assets (other than Fixed_Income) display negative skew and excess kurtosis, showing a leptokurtic distribution. Additionally the Jarque-Bera statistics are high and related p-value strongly suggest that UK asset weekly returns do not follow normal distributions.

Barring Fixed_Income and Currency all other assets make positive returns in Bull markets and negative in Bear markets. Fixed_Income had the lowest risk with a weekly standard deviation of 0.87% overall and made positive returns in the Bear market.

Commodity was the most lucrative asset with 162% returns overall and the highest weekly volatility at 3.35%.

The relationship between risk and return shown in Figure 4.4a is positive and consistent with higher returns requiring a larger risk appetite. Small_Cap is highlighted red because of limited data which may explain its position far from the line since it is missing the positive return benefits from the first Bull market.



4.4.2 Correlation Analysis

Figure 4.4c shows the correlations matrix for all assets in the European market.

Small_Cap, Large_Cap and Broad_Market correlations are consistently strong and positive to be expected. Equity against Fixed_Income correlations are weak or negative and mostly statistically insignificant. Equities against REIT, Private_Equity and Commodities display a pattern of increasing correlations in the Bear market and reducing correlations in Bull markets. Currency has an unusual behaviour with positive correlations against Small_Cap and Broad_Market but uncorrelated against Large_Cap.

Fixed_Income is uncorrelated with all asset types, again displaying unique qualities over other assets.

REITs display correlations of roughly 0.7 against most assets, -0.052 against Fixed_Income and 0.006 against Currency. These results are very similar in terms of their non-correlation with the UK market. Private_Equity displays a similar correlation pattern.

Like the UK market Fixed_Income and Currency have noticeably weaker correlations with all other assets, in both Bear and Bull markets, showing

these assets can be considered dependent on differing factors to other assets.

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Table 4.4b Europe ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
	SMALL_CAP				LARGE_CAP			
Mean	0.08%	NA	-1.16%	0.34%	0.17%	0.32%	-0.90%	0.29%
Median	0.26%	NA	-0.74%	0.45%	0.29%	0.39%	-0.71%	0.48%
Maximum	8.77%	NA	7.91%	8.77%	13.53%	4.95%	13.53%	8.26%
Minimum	-22.56%	NA	-22.56%	-10.41%	-21.24%	-5.87%	-21.24%	-8.31%
Std. Dev.	3.33%	NA	4.95%	2.80%	2.55%	1.67%	4.79%	2.31%
Skewness	-1.147	NA	-1.191	-0.320	-1.032	-0.458	-0.577	-0.320
Kurtosis	8.887	NA	6.868	4.202	13.787	4.050	7.821	3.990
Jarque-Bera	615.52	NA	56.73	23.56	3085.91	19.41	72.69	17.64
Probability	0.000	NA	0.000	0.000	0.000	0.000	0.000	0.000
Sum	30.47%	NA	-76.37%	103.51%	103.72%	76.09%	-64.16%	88.67%
Sum Sq. Dev.	0.409	NA	0.159	0.239	0.398	0.067	0.161	0.162
Observations	370	0	66	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
	REIT				PRIVATE_EQUITY			
Mean	0.22%	0.41%	-1.31%	0.43%	0.21%	0.44%	-1.85%	0.48%
Median	0.56%	0.63%	-0.72%	0.60%	0.43%	0.50%	-1.86%	0.50%
Maximum	10.85%	5.70%	10.03%	10.85%	12.43%	4.59%	11.07%	12.43%
Minimum	-19.80%	-8.92%	-19.80%	-13.90%	-25.43%	-6.15%	-25.43%	-12.06%
Std. Dev.	3.25%	2.15%	5.77%	3.07%	3.10%	1.61%	5.73%	2.98%
Skewness	-1.140	-0.896	-0.749	-0.385	-1.389	-0.993	-0.989	0.043
Kurtosis	8.531	5.656	3.992	5.871	14.754	6.082	6.708	6.794
Jarque-Bera	915.74	102.67	9.55	112.27	3732.11	134.43	52.24	183.06
Probability	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000
Sum	133.58%	99.08%	-92.67%	131.09%	128.22%	105.34%	-131.53%	147.04%
Sum Sq. Dev.	0.648	0.110	0.233	0.287	0.590	0.062	0.230	0.270
Observations	614	240	71	305	614	240	71	305

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Table 4.4b Europe ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.21%	0.52%	-1.17%	0.28%	0.07%	0.07%	0.09%	0.06%
Median	0.45%	0.67%	-0.52%	0.39%	0.11%	0.11%	0.14%	0.07%
Maximum	12.84%	5.51%	12.84%	11.97%	3.20%	1.11%	1.52%	3.20%
Minimum	-20.31%	-7.04%	-20.31%	-13.01%	-3.30%	-1.18%	-1.55%	-3.30%
Std. Dev.	3.39%	2.13%	5.23%	3.58%	0.87%	0.41%	0.65%	1.14%
Skewness	-0.614	-0.477	-0.518	-0.154	-0.083	-0.234	-0.263	-0.040
Kurtosis	6.456	3.913	5.043	3.853	4.937	3.020	2.920	3.292
Jarque-Bera	344.13	17.43	15.53	10.45	96.67	2.19	0.84	1.16
Probability	0.000	0.000	0.000	0.005	0.000	0.335	0.657	0.559
Sum	127.72%	125.24%	-83.02%	84.98%	42.68%	17.36%	6.19%	18.92%
Sum Sq. Dev.	0.702	0.109	0.191	0.389	0.047	0.004	0.003	0.040
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	0.02%	0.08%	0.10%	-0.04%
Median	0.46%	0.91%	-0.36%	0.16%	0.06%	0.13%	0.19%	-0.03%
Maximum	18.06%	6.85%	18.06%	9.29%	3.55%	1.93%	3.55%	3.27%
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	-4.55%	-2.52%	-4.55%	-3.25%
Std. Dev.	3.35%	2.46%	6.10%	3.01%	0.90%	0.69%	1.25%	0.95%
Skewness	-0.459	-0.581	-0.079	-0.177	-0.263	-0.413	-0.528	-0.036
Kurtosis	9.262	3.874	5.726	4.724	4.982	3.947	5.397	3.687
Jarque-Bera	1024.73	21.12	22.06	39.35	107.57	15.79	20.29	6.06
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048
Sum	161.87%	154.51%	-40.82%	47.25%	14.55%	20.02%	7.00%	-10.69%
Sum Sq. Dev.	0.688	0.145	0.261	0.275	0.050	0.011	0.011	0.027
Observations	614	240	71	305	614	240	71	305

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Table 4.4c Europe ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	NA	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.834	NA	0.860	0.813	1	1	1	1				
	28.981	NA	13.500	24.290	-----	-----	-----	-----				
	0.000	NA	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.920	NA	0.939	0.911	0.805	0.680	0.856	0.824	1	1	1	1
	45.001	NA	21.767	38.456	33.605	14.314	13.743	25.290	-----	-----	-----	-----
	0.000	NA	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	0.064	NA	-0.212	0.138	-0.119	-0.288	-0.137	-0.102	0.112	-0.167	-0.289	0.251
	1.236	NA	-1.738	2.427	-2.971	-4.633	-1.148	-1.786	2.780	-2.612	-2.507	4.505
	0.217	NA	0.087	0.016	0.003	0.000	0.255	0.075	0.006	0.010	0.015	0.000
REIT	0.743	NA	0.771	0.702	0.760	0.595	0.812	0.757	0.676	0.515	0.726	0.683
	21.289	NA	9.682	17.170	28.888	11.432	11.566	20.156	22.678	9.266	8.757	16.261
	0.000	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	0.803	NA	0.782	0.811	0.842	0.782	0.876	0.832	0.724	0.549	0.762	0.745
	25.877	NA	10.043	24.108	38.630	19.376	15.091	26.085	25.959	10.146	9.769	19.468
	0.000	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COMMODITY	0.856	NA	0.857	0.866	0.764	0.542	0.827	0.807	0.815	0.705	0.861	0.846
	31.773	NA	13.289	30.150	29.262	9.941	12.211	23.824	34.749	15.343	14.042	27.637
	0.000	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CURRENCY	0.326	NA	0.261	0.375	-0.025	-0.204	-0.023	0.050	0.422	0.377	0.311	0.499
	6.623	NA	2.165	7.041	-0.609	-3.217	-0.192	0.874	11.515	6.282	2.717	10.030
	0.000	NA	0.034	0.000	0.543	0.002	0.848	0.383	0.000	0.000	0.008	0.000

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1	1	1	1												
	-----	-----	-----	-----												
	-----	-----	-----	-----												
REIT	-0.052	-0.111	-0.125	-0.032	1	1	1	1								
	-1.298	-1.718	-1.050	-0.558	-----	-----	-----	-----								
	0.195	0.087	0.297	0.577	-----	-----	-----	-----								
PRIVATE_EQUITY	-0.081	-0.189	-0.184	-0.048	0.776	0.688	0.801	0.754	1	1	1	1				
	-2.010	-2.973	-1.552	-0.828	30.442	14.632	11.133	19.983	-----	-----	-----	-----				
	0.045	0.003	0.125	0.408	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
COMMODITY	-0.011	-0.131	-0.308	0.098	0.607	0.433	0.634	0.649	0.686	0.496	0.725	0.740	1	1	1	1
	-0.263	-2.042	-2.691	1.708	18.881	7.419	6.812	14.864	23.339	8.817	8.742	19.169	-----	-----	-----	-----
	0.793	0.042	0.009	0.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
CURRENCY	0.500	0.130	-0.088	0.718	0.006	-0.082	-0.081	0.106	-0.027	-0.252	-0.093	0.082	0.282	0.325	0.246	0.291
	14.291	2.023	-0.737	17.933	0.149	-1.271	-0.674	1.849	-0.669	-4.021	-0.772	1.438	7.263	5.304	2.104	5.288
	0.000	0.044	0.464	0.000	0.882	0.205	0.503	0.066	0.504	0.000	0.443	0.151	0.000	0.000	0.039	0.000

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4.5 Australia

The Australian market had data coverage for all assets other than Fixed_Income, where returns data was non-existent for the Bull and Bear market and limited for the second Bull market and Private_Equity, where no suitable ETF or index could be found. Data was highlighted in red when incomplete. The Australian Risk/Return graph is given in Figure 4.5a; descriptive data in Table 4.5b and Correlation matrix in Table 4.5c.

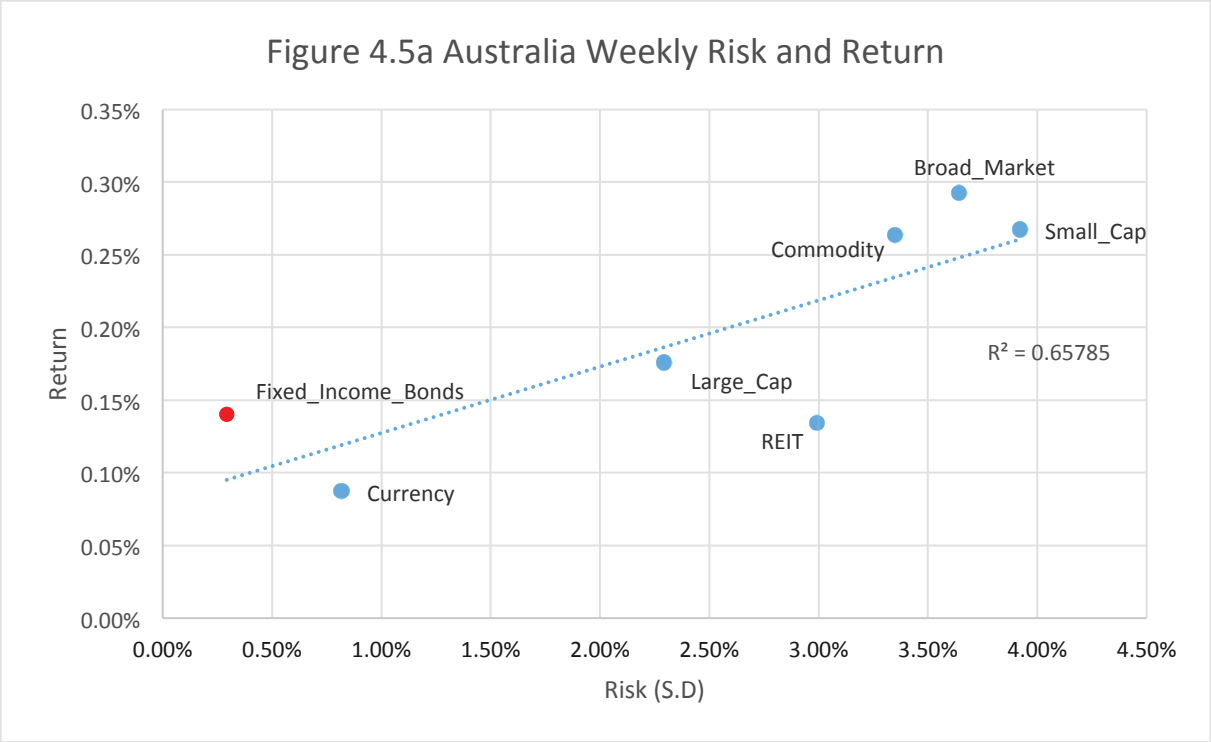
4.5.1 Descriptive Statistics

Descriptive data for the Australian market is given in Table 4.5b. Other than Fixed_Income all assets display negative skew and excess kurtosis, indicative of a leptokurtic distribution. Additionally Jarque-Bera values strongly suggest a normal distribution is not suitable.

The most lucrative assets in the Australian market were Broad_Market, Small_Cap and Commodity with 180%, 164% and 161% respectively.

All assets made positive returns in Bull markets and negative returns in the Bear market. If complete data had been available for Fixed_Income, it would be expected to be the only asset to make a positive return during a Bear market, judging from previous markets. The limited data for Fixed_Income show it was the least risky asset with a weekly standard deviation of 0.29%.

Figure 4.5a gives the Risk/Return graph for Australia; the relationship is not particularly strong but there does seem to be evidence that higher returns necessitated accepting higher risks. Additionally Small_Cap can be seen to make greater returns than Large_Cap but at an increased risk. Moreover, Broad_Market made better returns than both; an unexpected result considering Broad_Market should be a mix of Small and Large_Cap.



4.5.2 Correlation Analysis

The Australian Correlation Matrix is displayed in Table 4.5c. Small_Cap, Large_Cap and Broad_Market have consistently strong positive cross-correlations overall and between market types. Against REIT and Commodity, moderate positive correlations against equities increase from Bull1 to Bear then reduce in Bull2. Equity correlations against Currency are statistically significant and positive but relatively low; especially in Bull markets. These correlations increase during the Bear market then reduce during the Bull2 market.

Fixed_Income correlations are statistically negative against all assets in the Bull2 market and is the only asset to exhibit negative correlations.

REITs and Commodity exhibit positive correlations in all market periods; with a higher correlation in Bear than Bull markets

Currency also display this same pattern, with low to moderate correlations against all assets (other than Fixed_Income) and higher correlations in Bear than Bull markets.

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Table 4.5b Australia ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.27%	0.70%	-1.59%	0.36%	0.18%	0.34%	-0.81%	0.27%
Median	0.65%	0.96%	-0.42%	0.24%	0.33%	0.43%	-1.07%	0.42%
Maximum	13.21%	12.62%	10.47%	13.21%	11.62%	7.89%	11.62%	8.09%
Minimum	-32.85%	-13.37%	-32.85%	-15.55%	-15.19%	-5.54%	-15.19%	-7.41%
Std. Dev.	3.92%	2.49%	6.59%	3.90%	2.29%	1.51%	3.96%	2.22%
Skewness	-1.433	-0.850	-1.726	-0.066	-0.654	-0.308	-0.276	-0.226
Kurtosis	13.227	9.049	9.158	4.582	8.329	6.698	5.302	4.257
Jarque-Bera	2885.87	394.78	147.46	32.03	770.24	140.53	16.58	22.68
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	164.30%	168.45%	-112.87%	109.83%	107.94%	82.68%	-57.74%	81.88%
Sum Sq. Dev.	0.942	0.148	0.304	0.462	0.322	0.055	0.110	0.150
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	0.13%	0.35%	-1.52%	0.36%	NA	NA	NA	NA
Median	0.32%	0.40%	-0.86%	0.35%	NA	NA	NA	NA
Maximum	15.87%	6.19%	13.29%	15.87%	NA	NA	NA	NA
Minimum	-20.27%	-5.88%	-20.27%	-14.96%	NA	NA	NA	NA
Std. Dev.	2.99%	1.74%	5.95%	2.61%	NA	NA	NA	NA
Skewness	-1.295	-0.040	-0.762	0.128	NA	NA	NA	NA
Kurtosis	14.070	3.772	4.554	12.235	NA	NA	NA	NA
Jarque-Bera	3306.64	6.03	14.01	1084.73	NA	NA	NA	NA
Probability	0.000	0.049	0.001	0.000	NA	NA	NA	NA
Sum	82.70%	84.98%	-107.87%	108.36%	NA	NA	NA	NA
Sum Sq. Dev.	0.549	0.072	0.248	0.207	NA	NA	NA	NA
Observations	614	240	71	305	0	0	0	0

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Table 4.5b Australia ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.29%	0.65%	-1.18%	0.36%	0.14%	NA	NA	0.14%
Median	0.50%	0.98%	-0.80%	0.36%	0.14%	NA	NA	0.14%
Maximum	13.35%	11.81%	13.35%	12.71%	1.74%	NA	NA	1.74%
Minimum	-25.94%	-8.76%	-25.94%	-11.54%	-0.80%	NA	NA	-0.80%
Std. Dev.	3.64%	2.55%	6.05%	3.57%	0.29%	NA	NA	0.29%
Skewness	-0.807	-0.429	-0.861	0.024	0.452	NA	NA	0.452
Kurtosis	8.652	5.124	6.032	4.337	6.330	NA	NA	6.330
Jarque-Bera	883.85	52.48	35.98	22.75	129.00	NA	NA	129.00
Probability	0.000	0.000	0.000	0.000	0.000	NA	NA	0.000
Sum	179.69%	156.92%	-84.10%	110.53%	36.48%	NA	NA	36.48%
Sum Sq. Dev.	0.813	0.155	0.256	0.388	0.002	NA	NA	0.002
Observations	614	240	71	305	260	0	0	260

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	0.09%	0.21%	-0.03%	0.03%
Median	0.46%	0.91%	-0.36%	0.16%	0.14%	0.28%	0.04%	0.06%
Maximum	18.06%	6.85%	18.06%	9.29%	3.27%	2.14%	2.72%	3.27%
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	-4.19%	-2.55%	-4.19%	-2.71%
Std. Dev.	3.35%	2.46%	6.10%	3.01%	0.82%	0.73%	1.11%	0.79%
Skewness	-0.459	-0.581	-0.079	-0.177	-0.575	-0.678	-0.800	-0.208
Kurtosis	9.262	3.874	5.726	4.724	5.377	4.525	5.514	4.543
Jarque-Bera	1024.73	21.12	22.06	39.35	178.44	41.65	26.26	32.45
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	161.87%	154.51%	-40.82%	47.25%	53.74%	49.37%	-2.33%	8.48%
Sum Sq. Dev.	0.688	0.145	0.261	0.275	0.041	0.013	0.009	0.019
Observations	614	240	71	305	614	240	71	305

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Table 4.5c Australian ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	1	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.776	0.664	0.801	0.786	1	1	1	1				
	30.465	13.699	11.115	22.106	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.856	0.834	0.862	0.852	0.791	0.704	0.790	0.811	1	1	1	1
	40.926	23.361	14.131	28.324	31.933	15.309	10.697	24.130	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	-0.373	NA	NA	-0.373	-0.364	NA	NA	-0.364	-0.432	NA	NA	-0.432
	-6.456	NA	NA	-6.456	-6.281	NA	NA	-6.281	-7.703	NA	NA	-7.703
	0.000	NA	NA	0.000	0.000	NA	NA	0.000	0.000	NA	NA	0.000
REIT	0.565	0.418	0.669	0.500	0.627	0.525	0.650	0.625	0.492	0.396	0.501	0.497
	16.931	7.098	7.480	10.043	19.921	9.522	7.097	13.951	13.975	6.662	4.812	9.969
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COMMODITY	0.771	0.650	0.828	0.781	0.695	0.598	0.720	0.715	0.826	0.704	0.848	0.868
	29.923	13.194	12.264	21.799	23.894	11.507	8.622	17.818	36.218	15.283	13.283	30.414
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CURRENCY	0.424	0.299	0.524	0.434	0.354	0.268	0.354	0.399	0.415	0.271	0.514	0.431
	11.598	4.835	5.107	8.385	9.374	4.294	3.145	7.578	11.268	4.351	4.982	8.318
	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1	NA	NA	1												
	-----	NA	NA	-----												
	-----	NA	NA	-----												
REIT	-0.196	NA	NA	-0.196	1	1	1	1								
	-3.208	NA	NA	-3.208	-----	-----	-----	-----								
	0.002	NA	NA	0.002	-----	-----	-----	-----								
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	-----	-----	-----	-----				
	NA	NA	NA	NA	NA	NA	NA	NA	-----	-----	-----	-----				
COMMODITY	-0.401	NA	NA	-0.401	0.397	0.227	0.452	0.397	NA	NA	NA	NA	1	1	1	1
	-7.033	NA	NA	-7.033	10.707	3.591	4.204	7.521	NA	NA	NA	NA	-----	-----	-----	-----
	0.000	NA	NA	0.000	0.000	0.000	0.000	0.000	NA	NA	NA	NA	-----	-----	-----	-----
CURRENCY	-0.152	NA	NA	-0.152	0.296	0.207	0.368	0.311	NA	NA	NA	NA	0.373	0.226	0.408	0.430
	-2.475	NA	NA	-2.475	7.655	3.270	3.283	5.693	NA	NA	NA	NA	9.939	3.572	3.717	8.284
	0.014	NA	NA	0.014	0.000	0.001	0.002	0.000	NA	NA	NA	NA	0.000	0.000	0.000	0.000

Error! Unknown **switch argument.**

4.6 Japan

The Japanese market had good data coverage for all assets other than Fixed_Income, where returns data was non-existent the Bull and Bear market, and limited for the second Bull market. No suitable ETF or index could be found for Private_Equity and Currency. Data was highlighted in red when incomplete. The Japanese Risk/Return graph is given in Figure 4.6a; descriptive data in Table 4.6b and Correlation matrix in Table 4.6c.

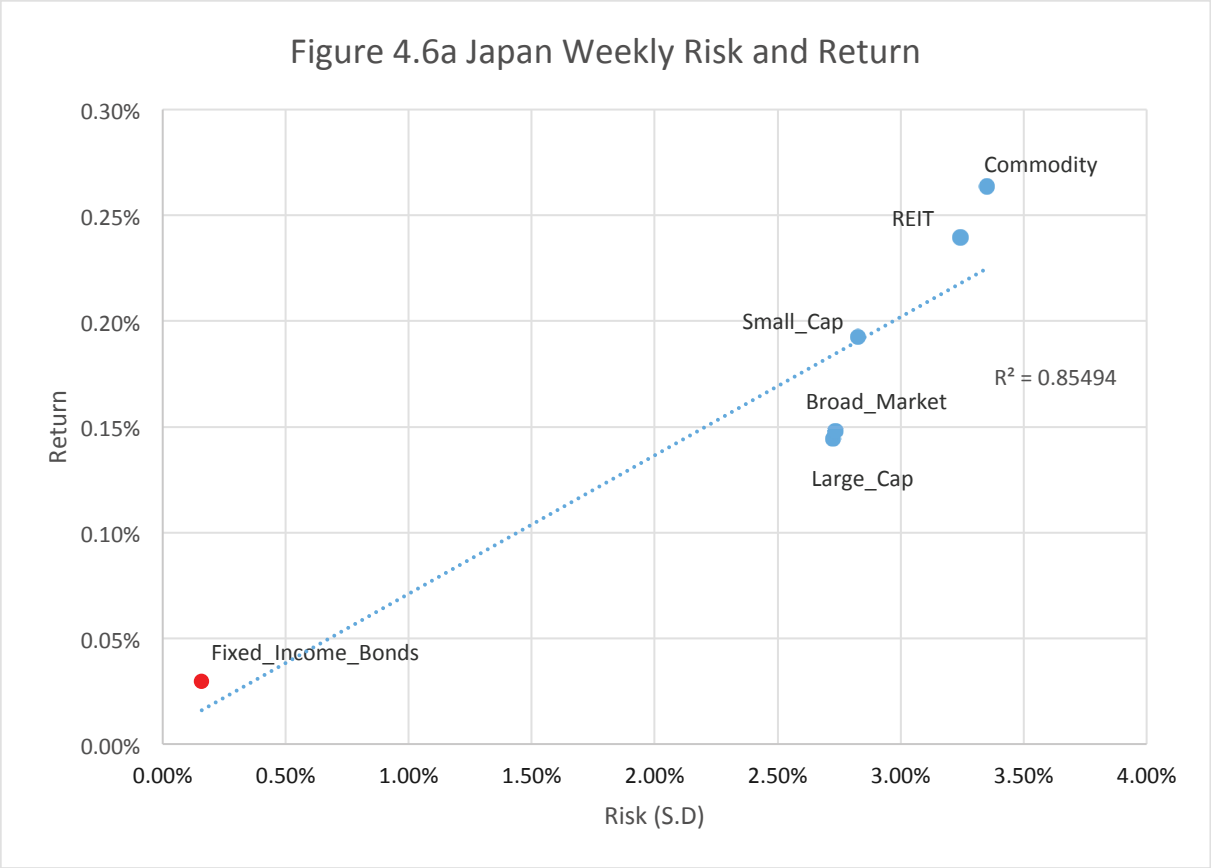
4.6.1 Descriptive Statistics

Descriptive statistics are displayed in Table 4.6b. All assets display negative skew and significant excess kurtosis, indicating a leptokurtic distribution. High Jarque-Bera values show that weekly returns do not follow a normal distribution.

Assets generally make positive returns in both Bull markets and negative returns in the Bear market.

Commodities make the greatest returns overall with 161%. Fixed_Income the least at 8% with the minimum weekly risk at 0.16%; this result is untrustworthy due to the limited data, but consistent with Fixed_Income data in previous markets.

The Risk/Return graph in Figure 4.6a suggests that greater returns required greater risk, but the trend line is heavily influenced by the limited data Fixed_Income asset. Removing Fixed_Income improves the R^2 value of the trend line and the line becomes steeper and it is still consistent with the prediction of greater risk leads to greater returns.



4.6.2 Correlation Analysis

The Correlation matrix is given in Table 4.6c. Between the equity assets of Small_Cap, Large_Cap and Broad_Market correlations are strong over all markets, displaying a tendency to strengthen over the market types. Against REIT correlations are low in Bull markets and high in the Bear market; a similar pattern is shown against Commodity.

Fixed_Income again appears unique against other assets with correlations that are lightly negative in the Bull2 market.

Between REIT and Commodity correlations are weak in both Bull markets and strong in the Bear market.

There is an overarching trend of weaker correlations in Bull markets and stronger correlations in Bear markets, other than Fixed_Income with its negative correlations.

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Table 4.6b Japan ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.19%	0.39%	-0.70%	0.23%	0.14%	0.36%	-0.79%	0.19%
Median	0.24%	0.29%	-0.66%	0.33%	0.24%	0.38%	-0.25%	0.22%
Maximum	17.57%	7.26%	17.57%	6.07%	8.47%	7.91%	8.47%	8.02%
Minimum	-20.53%	-9.47%	-20.53%	-6.82%	-17.19%	-9.28%	-17.19%	-6.96%
Std. Dev.	2.83%	2.87%	4.51%	2.19%	2.73%	2.63%	4.03%	2.37%
Skewness	-0.506	-0.394	-0.213	-0.300	-0.430	0.069	-0.871	0.066
Kurtosis	9.892	3.703	10.303	3.241	6.137	3.810	5.931	3.616
Jarque-Bera	1241.33	11.14	158.29	5.31	270.58	6.76	34.38	5.05
Probability	0.000	0.004	0.000	0.070	0.000	0.034	0.000	0.080
Sum	118.21%	94.13%	-50.04%	68.99%	88.70%	85.36%	-56.25%	59.05%
Sum Sq. Dev.	0.490	0.197	0.142	0.146	0.455	0.165	0.114	0.171
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	0.24%	0.36%	-0.93%	0.42%	NA	NA	NA	NA
Median	0.34%	0.42%	-0.91%	0.33%	NA	NA	NA	NA
Maximum	17.86%	11.50%	17.86%	12.75%	NA	NA	NA	NA
Minimum	-26.86%	-14.78%	-26.86%	-11.06%	NA	NA	NA	NA
Std. Dev.	3.24%	2.43%	6.43%	2.58%	NA	NA	NA	NA
Skewness	-0.905	-0.723	-0.505	0.299	NA	NA	NA	NA
Kurtosis	15.551	12.785	6.688	6.470	NA	NA	NA	NA
Jarque-Bera	4100.70	970.24	43.26	157.62	NA	NA	NA	NA
Probability	0.000	0.000	0.000	0.000	NA	NA	NA	NA
Sum	146.49%	86.67%	-65.82%	128.41%	NA	NA	NA	NA
Sum Sq. Dev.	0.642	0.140	0.289	0.202	NA	NA	NA	NA
Observations	612	238	71	305	0	0	0	0

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Table 4.6b Japan ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.15%	0.36%	-0.77%	0.19%	0.03%	NA	NA	0.03%
Median	0.22%	0.31%	-1.01%	0.19%	0.05%	NA	NA	0.05%
Maximum	8.46%	7.74%	8.46%	7.28%	0.44%	NA	NA	0.44%
Minimum	-18.09%	-9.62%	-18.09%	-6.69%	-0.63%	NA	NA	-0.63%
Std. Dev.	2.74%	2.60%	4.23%	2.34%	0.16%	NA	NA	0.16%
Skewness	-0.524	0.000	-0.793	-0.039	-0.905	NA	NA	-0.905
Kurtosis	6.661	3.840	6.040	3.433	5.360	NA	NA	5.360
Jarque-Bera	370.90	7.05	34.78	2.46	95.80	NA	NA	95.80
Probability	0.000	0.029	0.000	0.292	0.000	NA	NA	0.000
Sum	90.86%	85.22%	-54.94%	59.16%	7.72%	NA	NA	7.72%
Sum Sq. Dev.	0.459	0.162	0.125	0.166	0.001	NA	NA	0.001
Observations	614	240	71	305	260	0	0	260

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	NA	NA	NA	NA
Median	0.46%	0.91%	-0.36%	0.16%	NA	NA	NA	NA
Maximum	18.06%	6.85%	18.06%	9.29%	NA	NA	NA	NA
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	NA	NA	NA	NA
Std. Dev.	3.35%	2.46%	6.10%	3.01%	NA	NA	NA	NA
Skewness	-0.459	-0.581	-0.079	-0.177	NA	NA	NA	NA
Kurtosis	9.262	3.874	5.726	4.724	NA	NA	NA	NA
Jarque-Bera	1024.73	21.12	22.06	39.35	NA	NA	NA	NA
Probability	0.000	0.000	0.000	0.000	NA	NA	NA	NA
Sum	161.87%	154.51%	-40.82%	47.25%	NA	NA	NA	NA
Sum Sq. Dev.	0.688	0.145	0.261	0.275	NA	NA	NA	NA
Observations	614	240	71	305	0	0	0	0

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Table 4.6c Japan ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	1	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.830	0.777	0.867	0.860	1	1	1	1				
	36.791	18.951	14.419	29.371	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.850	0.800	0.875	0.885	0.979	0.979	0.977	0.981	1	1	1	1
	39.927	20.480	15.002	33.119	118.990	72.978	37.940	88.953	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	-0.057	NA	NA	-0.057	-0.181	NA	NA	-0.181	-0.181	NA	NA	-0.181
	-0.912	NA	NA	-0.912	-2.948	NA	NA	-2.948	-2.953	NA	NA	-2.953
	0.363	NA	NA	0.363	0.004	NA	NA	0.004	0.003	NA	NA	0.003
REIT	0.479	0.316	0.633	0.456	0.473	0.247	0.715	0.430	0.479	0.262	0.705	0.424
	13.461	5.121	6.792	8.907	13.263	3.909	8.490	8.293	13.486	4.174	8.251	8.154
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COMMODITY	0.533	0.385	0.706	0.511	0.645	0.530	0.800	0.624	0.640	0.529	0.777	0.620
	15.565	6.403	8.280	10.352	20.819	9.594	11.076	13.891	20.580	9.576	10.245	13.744
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CURRENCY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1	NA	NA	1												
	-----	NA	NA	-----												
	-----	NA	NA	-----												
REIT	0.064	NA	NA	0.064	1	1	1	1								
	1.035	NA	NA	1.035	-----	-----	-----	-----								
	0.302	NA	NA	0.302	-----	-----	-----	-----								
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
COMMODITY	-0.237	NA	NA	-0.237	0.416	0.272	0.652	0.216	NA	NA	NA	NA	1	1	1	1
	-3.927	NA	NA	-3.927	11.300	4.348	7.146	3.851	NA	NA	NA	NA	-----	-----	-----	-----
	0.000	NA	NA	0.000	0.000	0.000	0.000	0.000	NA	NA	NA	NA	-----	-----	-----	-----
CURRENCY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Error! Unknown **switch argument.**

4.7 BRIC (Brazil, Russia, India, China)

The following BRIC markets are separated because they are classed as developing markets and hence some have limited data or missing assets. For each market any data that was limited or unavailable is highlighted in red.

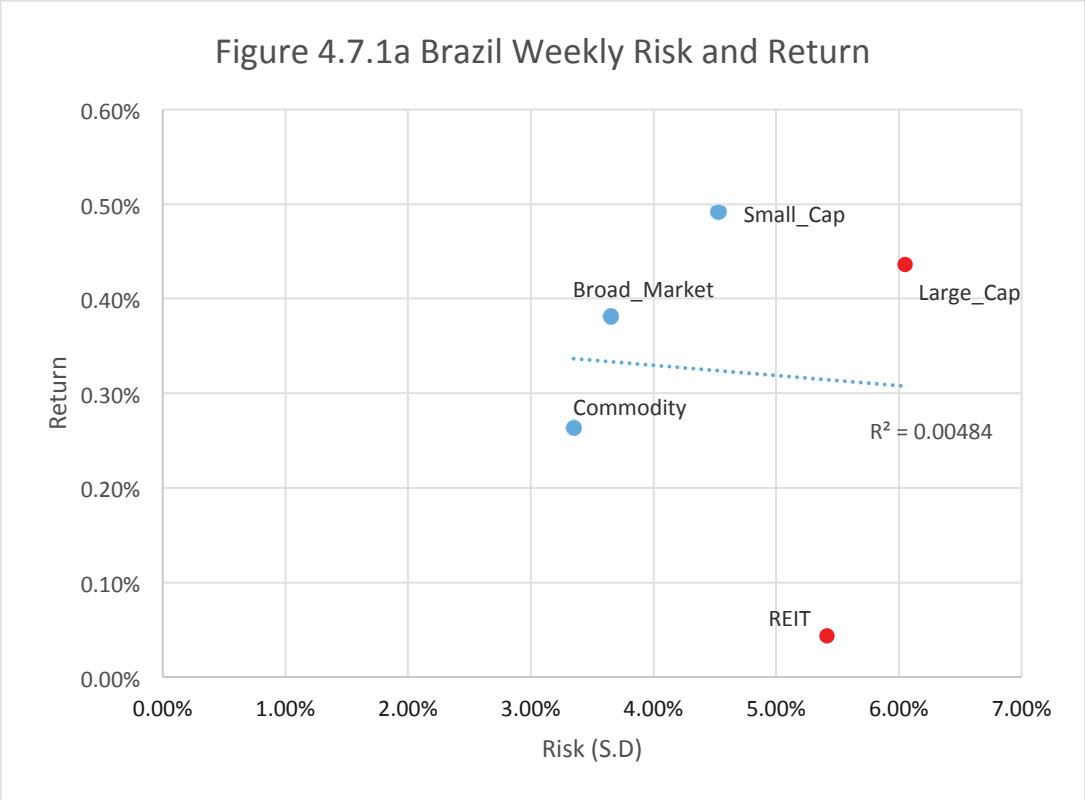
4.7.1 Brazil

The Brazilian Risk/Return graph is given in Figure 4.7.1a; descriptive data in Table 4.7.1b and Correlation matrix in Table 4.7.1c.

Suitable ETF or index data could not be found for the Fixed_Income, Private_Equity and Currency assets and Data was limited for Large_Cap and REIT assets.

Weekly return data displays negative skew and excess kurtosis for all assets, more evidence for leptokurtosis. Jarque-Bera values also indicate that a normal distribution is not suitable. Only in Broad_Market Bull markets is there evidence that a normal distribution could adequately describe weekly returns.

The Risk/Return graph in Figure 4.7.1a does not show a relationship between risk and return; this is not helped by the missing asset data.



Correlations between Small_Cap, Large_Cap and Broad_Market are consistently very strong other than where data was limited in the Bull1 market. REIT correlations against equities are consistently higher in the Bear market than the Bull2 market. Commodities follow the same pattern; where correlations are higher in the Bear market than in the Bull market.

Between REIT and Commodity correlations were higher in the Bear market than the Bull2 market. Fitting the common picture that correlations strengthen during Bear markets.

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Table 4.7.1b Brazil ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.49%	1.16%	-1.24%	0.37%	0.44%	1.31%	-0.55%	0.17%
Median	0.71%	1.41%	-0.75%	0.59%	0.46%	1.58%	-0.68%	0.18%
Maximum	17.65%	12.21%	17.65%	11.34%	29.58%	29.35%	29.58%	12.41%
Minimum	-31.21%	-11.96%	-31.21%	-13.37%	-30.07%	-30.07%	-27.86%	-13.97%
Std. Dev.	4.53%	3.98%	7.77%	3.73%	6.05%	6.92%	9.66%	4.04%
Skewness	-0.874	-0.368	-0.651	-0.433	-0.090	-0.515	0.346	-0.051
Kurtosis	8.223	3.297	5.725	4.339	9.207	8.484	5.228	3.912
Jarque-Bera	776.11	6.31	26.98	32.33	893.24	236.12	16.09	10.71
Probability	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.005
Sum	301.80%	278.49%	-87.70%	114.14%	242.35%	238.74%	-38.84%	51.01%
Sum Sq. Dev.	1.257	0.379	0.423	0.424	2.033	0.867	0.653	0.496
Observations	614	240	71	305	556	182	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	0.04%	NA	-1.49%	0.33%	NA	NA	NA	NA
Median	-0.01%	NA	-1.79%	0.26%	NA	NA	NA	NA
Maximum	28.26%	NA	28.26%	15.57%	NA	NA	NA	NA
Minimum	-30.65%	NA	-30.65%	-11.95%	NA	NA	NA	NA
Std. Dev.	5.42%	NA	9.44%	4.15%	NA	NA	NA	NA
Skewness	-0.032	NA	0.226	0.317	NA	NA	NA	NA
Kurtosis	8.473	NA	4.887	4.096	NA	NA	NA	NA
Jarque-Bera	454.33	NA	9.41	20.39	NA	NA	NA	NA
Probability	0.000	NA	0.009	0.000	NA	NA	NA	NA
Sum	15.87%	NA	-89.61%	100.61%	NA	NA	NA	NA
Sum Sq. Dev.	1.065	NA	0.526	0.525	NA	NA	NA	NA
Observations	364	0	60	305	0	0	0	0

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Table 4.7.1b Brazil ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.38%	0.85%	-0.40%	0.20%	NA	NA	NA	NA
Median	0.58%	1.04%	-0.24%	0.31%	NA	NA	NA	NA
Maximum	18.45%	9.20%	18.45%	8.76%	NA	NA	NA	NA
Minimum	-19.93%	-9.12%	-19.93%	-9.91%	NA	NA	NA	NA
Std. Dev.	3.65%	3.39%	6.16%	2.98%	NA	NA	NA	NA
Skewness	-0.176	-0.384	0.136	0.008	NA	NA	NA	NA
Kurtosis	6.194	3.069	5.016	3.300	NA	NA	NA	NA
Jarque-Bera	264.11	5.95	12.24	1.15	NA	NA	NA	NA
Probability	0.000	0.051	0.002	0.563	NA	NA	NA	NA
Sum	233.92%	204.54%	-28.56%	62.26%	NA	NA	NA	NA
Sum Sq. Dev.	0.817	0.274	0.266	0.270	NA	NA	NA	NA
Observations	614	240	71	305	0	0	0	0

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	NA	NA	NA	NA
Median	0.46%	0.91%	-0.36%	0.16%	NA	NA	NA	NA
Maximum	18.06%	6.85%	18.06%	9.29%	NA	NA	NA	NA
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	NA	NA	NA	NA
Std. Dev.	3.35%	2.46%	6.10%	3.01%	NA	NA	NA	NA
Skewness	-0.459	-0.581	-0.079	-0.177	NA	NA	NA	NA
Kurtosis	9.262	3.874	5.726	4.724	NA	NA	NA	NA
Jarque-Bera	1024.73	21.12	22.06	39.35	NA	NA	NA	NA
Probability	0.000	0.000	0.000	0.000	NA	NA	NA	NA
Sum	161.87%	154.51%	-40.82%	47.25%	NA	NA	NA	NA
Sum Sq. Dev.	0.688	0.145	0.261	0.275	NA	NA	NA	NA
Observations	614	240	71	305	0	0	0	0

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Table 4.6.1c Brazil ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	1	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.739	0.476	0.905	0.873	1	1	1	1				
	25.795	7.259	17.624	31.217	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.852	0.873	0.879	0.801	0.769	0.471	0.968	0.914	1	1	1	1
	40.216	27.592	15.313	23.327	28.335	7.162	32.192	39.342	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
REIT	0.828	NA	0.883	0.767	0.761	NA	0.839	0.674	0.810	NA	0.876	0.745
	28.132	NA	14.309	20.833	22.342	NA	11.731	15.900	26.239	NA	13.831	19.416
	0.000	NA	0.000	0.000	0.000	NA	0.000	0.000	0.000	NA	0.000	0.000
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COMMODITY	0.734	0.618	0.846	0.706	0.720	0.447	0.931	0.803	0.775	0.696	0.888	0.738
	26.759	12.122	13.189	17.341	24.443	6.698	21.178	23.442	30.374	14.936	16.039	19.056
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CURRENCY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	NA	NA	NA	NA												
	NA	NA	NA	NA												
	NA	NA	NA	NA												
REIT	NA	NA	NA	NA	1	NA	1	1								
	NA	NA	NA	NA	-----	NA	-----	-----								
	NA	NA	NA	NA	-----	NA	-----	-----								
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
COMMODITY	NA	NA	NA	NA	0.641	NA	0.761	0.521	NA	NA	NA	NA	1	1	1	1
	NA	NA	NA	NA	15.879	NA	8.921	10.614	NA	NA	NA	NA	-----	-----	-----	-----
	NA	NA	NA	NA	0.000	NA	0.000	0.000	NA	NA	NA	NA	-----	-----	-----	-----
CURRENCY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Error! Unknown **switch argument.**

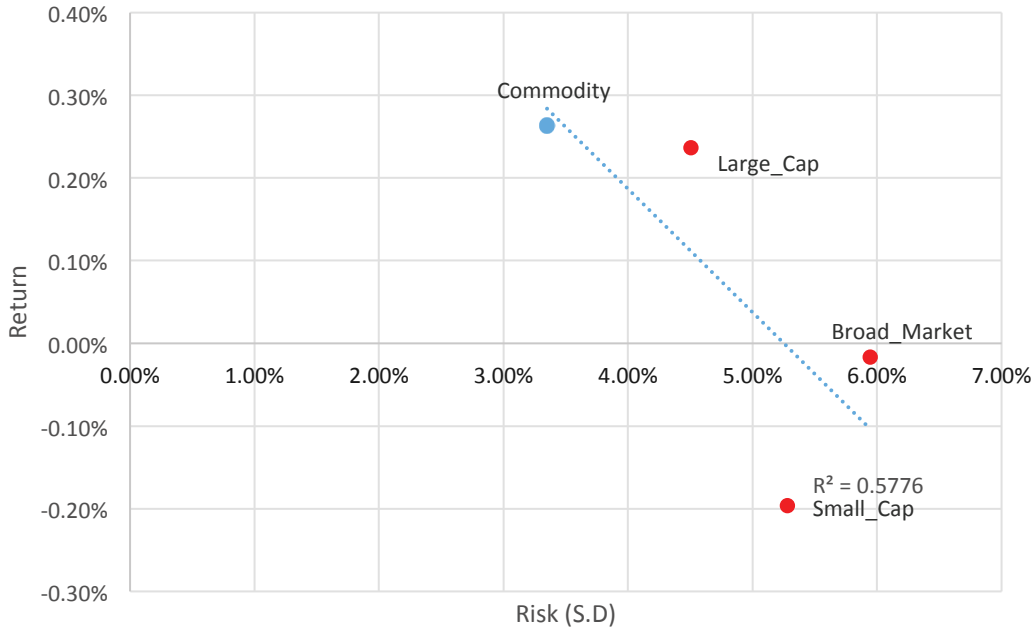
4.7.2 Russia

The Russian Risk/Return graph is given in Figure 4.7.2a; descriptive data in Table 4.7.2b and Correlation matrix in Table 4.7.2c.

Data for the Russian market was very poor; no suitable ETF or index data could be found for Fixed_Income, REIT, Private_Equity or Currency. Data was also limited for Small_Cap, Large_Cap, Broad_Market; the ETF market for Russia is clearly not well developed as of the time of writing.

The limited data gives rise to an unusual Risk/Return graph which, suggests that taking less risk resulted in greater returns.

Figure 4.7.2a Russia Weekly Risk and Return



The Russian Correlation Matrix is given in Table 4.7.2c, significantly empty from data limitations. From this the only relevant conclusion to be drawn is that Small_Cap, Large_Cap and Broad_Market equities have strong inter-correlations overall and in the different respective Bear and Bull market periods.

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Table 4.7.2b Russia ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
	SMALL_CAP				LARGE_CAP			
Mean	-0.20%	NA	-2.63%	0.29%	0.24%	NA	NA	0.24%
Median	0.22%	NA	-1.71%	0.58%	0.08%	NA	NA	0.08%
Maximum	22.63%	NA	22.63%	13.68%	15.20%	NA	NA	15.20%
Minimum	-32.86%	NA	-32.86%	-16.17%	-15.80%	NA	NA	-15.80%
Std. Dev.	5.28%	NA	8.41%	4.24%	4.51%	NA	NA	4.51%
Skewness	-0.757	NA	-0.339	-0.204	-0.082	NA	NA	-0.082
Kurtosis	9.126	NA	6.190	4.897	4.680	NA	NA	4.680
Jarque-Bera	605.57	NA	27.03	47.86	35.98	NA	NA	35.98
Probability	0.000	NA	0.000	0.000	0.000	NA	NA	0.000
Sum	-71.77%	NA	-160.31%	88.75%	71.77%	NA	NA	71.77%
Sum Sq. Dev.	1.015	NA	0.424	0.547	0.613	NA	NA	0.613
Observations	365	0	61	305	303	0	0	303

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
	REIT				PRIVATE_EQUITY			
Mean	NA	NA	NA	NA	NA	NA	NA	NA
Median	NA	NA	NA	NA	NA	NA	NA	NA
Maximum	NA	NA	NA	NA	NA	NA	NA	NA
Minimum	NA	NA	NA	NA	NA	NA	NA	NA
Std. Dev.	NA	NA	NA	NA	NA	NA	NA	NA
Skewness	NA	NA	NA	NA	NA	NA	NA	NA
Kurtosis	NA	NA	NA	NA	NA	NA	NA	NA
Jarque-Bera	NA	NA	NA	NA	NA	NA	NA	NA
Probability	NA	NA	NA	NA	NA	NA	NA	NA
Sum	NA	NA	NA	NA	NA	NA	NA	NA
Sum Sq. Dev.	NA	NA	NA	NA	NA	NA	NA	NA
Observations	0	0	0	0	0	0	0	0

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Table 4.7.2b Russia ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	-0.02%	1.02%	-1.39%	0.26%	NA	NA	NA	NA
Median	-0.02%	0.53%	-1.24%	0.17%	NA	NA	NA	NA
Maximum	47.14%	7.64%	47.14%	14.37%	NA	NA	NA	NA
Minimum	-27.68%	-6.66%	-27.68%	-15.95%	NA	NA	NA	NA
Std. Dev.	5.95%	3.62%	10.31%	4.52%	NA	NA	NA	NA
Skewness	0.439	-0.023	0.858	-0.121	NA	NA	NA	NA
Kurtosis	15.535	2.338	9.465	4.682	NA	NA	NA	NA
Jarque-Bera	2624.92	0.46	132.37	36.70	NA	NA	NA	NA
Probability	0.000	0.795	0.000	0.000	NA	NA	NA	NA
Sum	-6.68%	25.42%	-98.72%	79.44%	NA	NA	NA	NA
Sum Sq. Dev.	1.408	0.032	0.745	0.622	NA	NA	NA	NA
Observations	399	25	71	305	0	0	0	0

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	NA	NA	NA	NA
Median	0.46%	0.91%	-0.36%	0.16%	NA	NA	NA	NA
Maximum	18.06%	6.85%	18.06%	9.29%	NA	NA	NA	NA
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	NA	NA	NA	NA
Std. Dev.	3.35%	2.46%	6.10%	3.01%	NA	NA	NA	NA
Skewness	-0.459	-0.581	-0.079	-0.177	NA	NA	NA	NA
Kurtosis	9.262	3.874	5.726	4.724	NA	NA	NA	NA
Jarque-Bera	1024.73	21.12	22.06	39.35	NA	NA	NA	NA
Probability	0.000	0.000	0.000	0.000	NA	NA	NA	NA
Sum	161.87%	154.51%	-40.82%	47.25%	NA	NA	NA	NA
Sum Sq. Dev.	0.688	0.145	0.261	0.275	NA	NA	NA	NA
Observations	614	240	71	305	0	0	0	0

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Table 4.7.2c Russia ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	NA	1	1								
	-----	NA	-----	-----								
	-----	NA	-----	-----								
LARGE_CAP	0.817	NA	NA	0.817	1	NA	NA	1				
	24.625	NA	NA	24.625	-----	NA	NA	-----				
	0.000	NA	NA	0.000	-----	NA	NA	-----				
BROAD_MARKET	0.841	NA	0.847	0.844	0.936	NA	NA	0.936	1	1	1	1
	29.651	NA	12.216	27.261	46.182	NA	NA	46.182	-----	-----	-----	-----
	0.000	NA	0.000	0.000	0.000	NA	NA	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
REIT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COMMODITY	0.752	NA	0.795	0.720	0.760	NA	NA	0.760	0.813	0.799	0.809	0.830
	21.743	NA	10.077	18.017	20.268	NA	NA	20.268	27.868	6.373	11.424	25.806
	0.000	NA	0.000	0.000	0.000	NA	NA	0.000	0.000	0.000	0.000	0.000
CURRENCY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	NA	NA	NA	NA												
	NA	NA	NA	NA												
	NA	NA	NA	NA												
REIT	NA	NA	NA	NA	NA	NA	NA	NA								
	NA	NA	NA	NA	NA	NA	NA	NA								
	NA	NA	NA	NA	NA	NA	NA	NA								
PRIVATE_EQUITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
COMMODITY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-----	-----	-----	-----
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-----	-----	-----	-----
CURRENCY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Error! Unknown **switch argument.**

4.7.3 India

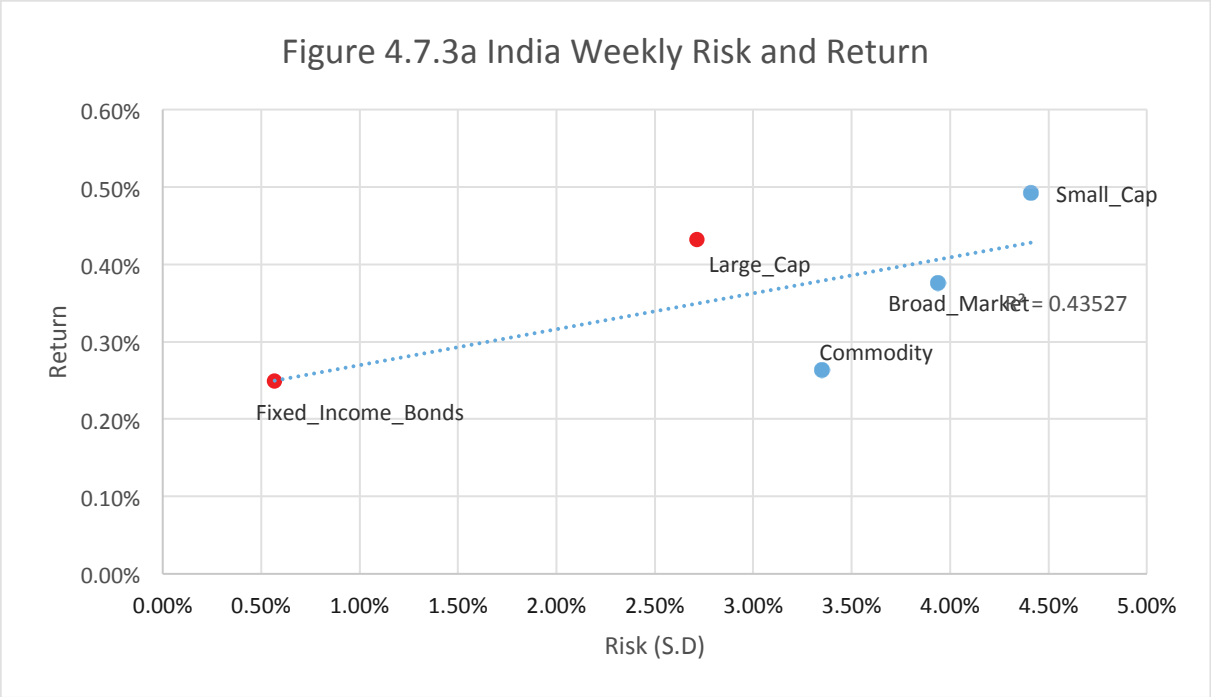
The Indian Risk/Return graph is given in Figure 4.7.3a; descriptive data in Table 4.7.3b and Correlation matrix in Table 4.7.3c.

Data for the Indian market was very poor, no suitable ETF or index data could be found for REIT, Private_Equity or Currency. Data was also limited for Large_Cap and Fixed_Income. The ETF market for India is clearly not well developed at the time of writing. As usual, where data was missing or limited, it has been highlighted in red.

Examining Figure 4.7.3b weekly returns for all assets display a mix of positive and negative skew and all significant positive excess kurtosis, showing a leptokurtic distribution. The Jarque-Bera values also indicate weekly returns do not follow a normal distribution.

Looking at the average weekly returns Small_Cap was the most lucrative Indian asset with 302% cumulative returns overall, also displaying the highest weekly standard deviation of any asset with 4.41%. Fixed_Income had the lowest weekly standard deviation at 0.57% but very limited data, meaning the result must be interpreted with caution.

The Indian Risk/Return graph in Figure 4.7.3a shows a weak positive (but quite flat) relationship. This means that if the risk premia relationship does hold true, a great deal of risk must be accepted to increase returns by a small amount.



The correlation matrix is shown in Figure 4.7.3c; it is very incomplete due to missing assets and data. Correlations are strongly positive between the equity assets of Small_Cap, Large_Cap and Broad_Market. Commodity correlations against equities appear reasonably stable at 0.55 across Bear and Bull markets. Fixed_Income is uncorrelated with other assets as has been the case with other markets.

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Table 4.7.3b India ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.49%	1.13%	-1.43%	0.45%	0.43%	NA	NA	0.43%
Median	0.75%	1.40%	-2.14%	0.31%	0.32%	NA	NA	0.32%
Maximum	34.12%	11.01%	11.02%	34.12%	13.31%	NA	NA	13.31%
Minimum	-24.07%	-13.64%	-24.07%	-11.96%	-9.77%	NA	NA	-9.77%
Std. Dev.	4.41%	3.37%	6.69%	4.39%	2.71%	NA	NA	2.71%
Skewness	0.105	-0.907	-0.297	1.365	0.552	NA	NA	0.552
Kurtosis	9.818	6.028	3.604	13.413	5.579	NA	NA	5.579
Jarque-Bera	1190.27	124.59	2.12	1472.72	99.38	NA	NA	99.38
Probability	0.000	0.000	0.346	0.000	0.000	NA	NA	0.000
Sum	302.25%	272.23%	-101.86%	138.16%	130.80%	NA	NA	130.80%
Sum Sq. Dev.	1.193	0.272	0.313	0.585	0.222	NA	NA	0.222
Observations	614	240	71	305	303	0	0	303

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	NA	NA	NA	NA	NA	NA	NA	NA
Median	NA	NA	NA	NA	NA	NA	NA	NA
Maximum	NA	NA	NA	NA	NA	NA	NA	NA
Minimum	NA	NA	NA	NA	NA	NA	NA	NA
Std. Dev.	NA	NA	NA	NA	NA	NA	NA	NA
Skewness	NA	NA	NA	NA	NA	NA	NA	NA
Kurtosis	NA	NA	NA	NA	NA	NA	NA	NA
Jarque-Bera	NA	NA	NA	NA	NA	NA	NA	NA
Probability	NA	NA	NA	NA	NA	NA	NA	NA
Sum	NA	NA	NA	NA	NA	NA	NA	NA
Sum Sq. Dev.	NA	NA	NA	NA	NA	NA	NA	NA
Observations	0	0	0	0	0	0	0	0

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Table 4.7.3b India ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.38%	0.89%	-1.17%	0.36%	0.25%	NA	NA	0.25%
Median	0.69%	1.37%	-1.36%	0.14%	0.30%	NA	NA	0.30%
Maximum	20.16%	10.08%	14.56%	20.16%	1.38%	NA	NA	1.38%
Minimum	-19.65%	-12.53%	-19.65%	-11.38%	-1.51%	NA	NA	-1.51%
Std. Dev.	3.94%	3.18%	6.38%	3.68%	0.57%	NA	NA	0.57%
Skewness	-0.240	-0.763	-0.032	0.548	-0.583	NA	NA	-0.583
Kurtosis	5.458	4.903	3.148	5.385	3.343	NA	NA	3.343
Jarque-Bera	160.47	59.52	0.08	87.55	3.32	NA	NA	3.32
Probability	0.000	0.000	0.963	0.000	0.190	NA	NA	0.190
Sum	230.51%	212.64%	-82.97%	108.77%	13.44%	NA	NA	13.44%
Sum Sq. Dev.	0.952	0.242	0.285	0.412	0.002	NA	NA	0.002
Observations	614	240	71	305	54	0	0	54

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	NA	NA	NA	NA
Median	0.46%	0.91%	-0.36%	0.16%	NA	NA	NA	NA
Maximum	18.06%	6.85%	18.06%	9.29%	NA	NA	NA	NA
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	NA	NA	NA	NA
Std. Dev.	3.35%	2.46%	6.10%	3.01%	NA	NA	NA	NA
Skewness	-0.459	-0.581	-0.079	-0.177	NA	NA	NA	NA
Kurtosis	9.262	3.874	5.726	4.724	NA	NA	NA	NA
Jarque-Bera	1024.73	21.12	22.06	39.35	NA	NA	NA	NA
Probability	0.000	0.000	0.000	0.000	NA	NA	NA	NA
Sum	161.87%	154.51%	-40.82%	47.25%	NA	NA	NA	NA
Sum Sq. Dev.	0.688	0.145	0.261	0.275	NA	NA	NA	NA
Observations	614	240	71	305	0	0	0	0

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Table 4.7.3c India ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
	SMALL_CAP				LARGE_CAP				BROAD_MARKET			
SMALL_CAP	1 ----- -----	1 ----- -----	1 ----- -----	1 ----- -----								
LARGE_CAP	0.796 22.844 0.000	NA NA NA	NA NA NA	0.796 22.844 0.000	1 ----- -----	NA NA NA	NA NA NA	1 ----- -----				
BROAD_MARKET	0.873 44.180 0.000	0.865 26.575 0.000	0.901 17.245 0.000	0.858 29.093 0.000	0.924 42.013 0.000	NA NA NA	NA NA NA	0.924 42.013 0.000	1 ----- -----	1 ----- -----	1 ----- -----	1 ----- -----
FIXED_INCOME_ BONDS	0.172 1.257 0.215	NA NA NA	NA NA NA	0.172 1.257 0.215	0.192 1.413 0.164	NA NA NA	NA NA NA	0.192 1.413 0.164	0.215 1.591 0.118	NA NA NA	NA NA NA	0.215 1.591 0.118
REIT	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA
PRIVATE_EQUITY	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA
COMMODITY	0.505 14.468 0.000	0.441 7.578 0.000	0.504 4.848 0.000	0.530 10.866 0.000	0.602 13.080 0.000	NA NA NA	NA NA NA	0.602 13.080 0.000	0.603 18.688 0.000	0.505 9.018 0.000	0.600 6.231 0.000	0.650 14.891 0.000
CURRENCY	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA

Correlation / t-Statistic / Probability	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
	FIXED_INCOME_BONDS				REIT				PRIVATE_EQUITY				COMMODITY			
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1 ----- -----	NA NA NA	NA NA NA	1 ----- -----												
REIT	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA								
PRIVATE_EQUITY	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA				
COMMODITY	-0.070 -0.507 0.614	NA NA NA	NA NA NA	-0.070 -0.507 0.614	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	1 ----- -----	1 ----- -----	1 ----- -----	1 ----- -----
CURRENCY	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA

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4.7.4 China

The China Risk/Return graph is given in Figure 4.7.4a; descriptive data in Table 4.7.4b and Correlation matrix in Table 4.7.4c.

Data for the Chinese market was good, if limited for Private_Equity and Currency. As usual, where data was missing or limited, it has been highlighted in red.

Examining Figure 4.7.3a; weekly returns for all assets display a mix of light positive and negative skew and all significant positive excess kurtosis, showing a leptokurtic distribution. The Jarque-Bera values also indicate weekly returns do not follow a normal distribution overall or in Bull markets. In the equity assets of Small_Cap, Large_Cap and Broad_Market the possibility of a normal distribution cannot be rejected.

The most lucrative asset class was REIT with 233% cumulative returns, also with the highest weekly standard deviation of 4.01%. Fixed_Income was the most stable asset with weekly standard deviation of 0.25%.

Figure 4.7.4a displays the overall weekly risk and return for all assets, revealing a trend similar to that seen in the developed markets.

Figure 4.7.4a China Weekly Risk and Return

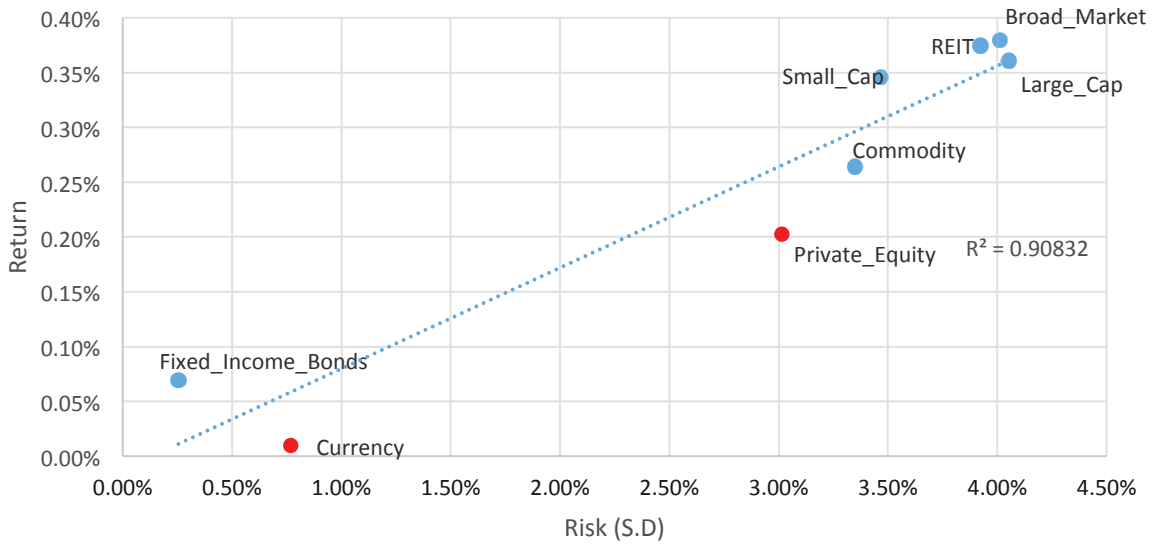

Table 4.7.4c displays the correlation matrix for China, containing some features seen in other markets. Firstly, cross-correlations for Small_Cap, Large_Cap and Broad_Market are strong overall and in Bear and Bull market types. Second Fixed_Income and Currency have very low correlations with all other asset types at all times.

For both REIT and Commodity against equities, correlations strengthen over the time period analysed from Bull1 to Bull2.

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Table 4.7.4b China ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		SMALL_CAP				LARGE_CAP		
Mean	0.35%	0.77%	-1.26%	0.37%	0.36%	0.93%	-1.15%	0.27%
Median	0.63%	0.90%	-1.18%	0.53%	0.43%	0.98%	-1.70%	0.05%
Maximum	14.85%	14.85%	11.34%	14.83%	16.28%	15.50%	16.28%	12.98%
Minimum	-18.38%	-12.13%	-18.38%	-11.89%	-20.84%	-9.73%	-20.84%	-11.84%
Std. Dev.	3.47%	3.03%	5.18%	3.18%	4.05%	3.59%	6.60%	3.51%
Skewness	-0.446	-0.374	-0.310	0.034	-0.132	-0.053	0.005	0.380
Kurtosis	5.856	6.262	3.667	5.201	5.116	3.951	3.476	4.164
Jarque-Bera	229.04	112.01	2.45	61.61	116.37	9.15	0.67	24.58
Probability	0.000	0.000	0.293	0.000	0.000	0.010	0.715	0.000
Sum	212.30%	184.25%	-89.70%	112.63%	221.41%	223.03%	-81.78%	81.96%
Sum Sq. Dev.	0.736	0.220	0.188	0.308	1.007	0.308	0.305	0.374
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		REIT				PRIVATE_EQUITY		
Mean	0.38%	0.86%	-1.18%	0.39%	0.20%	NA	NA	0.20%
Median	0.32%	0.70%	-1.91%	0.10%	0.24%	NA	NA	0.24%
Maximum	19.52%	13.04%	19.52%	16.83%	9.14%	NA	NA	9.14%
Minimum	-20.81%	-9.98%	-20.81%	-10.29%	-9.45%	NA	NA	-9.45%
Std. Dev.	4.01%	3.10%	6.89%	3.65%	3.02%	NA	NA	3.02%
Skewness	0.181	0.023	0.415	0.688	-0.081	NA	NA	-0.081
Kurtosis	6.042	4.289	3.962	4.733	3.033	NA	NA	3.033
Jarque-Bera	240.10	16.64	4.78	62.25	0.32	NA	NA	0.32
Probability	0.000	0.000	0.092	0.000	0.853	NA	NA	0.853
Sum	233.03%	205.20%	-83.43%	117.53%	56.32%	NA	NA	56.32%
Sum Sq. Dev.	0.986	0.230	0.332	0.405	0.252	NA	NA	0.252
Observations	614	240	71	305	278	0	0	278

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Table 4.7.4b China ETF Descriptive Data Weekly Returns

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		BROAD_MARKET				FIXED_INCOME_BONDS		
Mean	0.37%	0.94%	-1.18%	0.29%	0.07%	0.04%	0.15%	0.07%
Median	0.54%	0.98%	-1.21%	0.19%	0.07%	0.05%	0.10%	0.07%
Maximum	19.65%	19.65%	14.50%	17.08%	1.53%	1.09%	1.53%	0.64%
Minimum	-19.84%	-10.27%	-19.84%	-11.42%	-1.67%	-1.67%	-0.68%	-0.64%
Std. Dev.	3.92%	3.61%	6.35%	3.28%	0.25%	0.30%	0.33%	0.18%
Skewness	-0.004	0.178	0.074	0.518	-0.684	-1.323	1.153	-0.538
Kurtosis	5.935	5.933	3.400	5.696	12.164	10.473	7.241	6.001
Jarque-Bera	220.38	87.30	0.54	106.04	2196.58	628.49	68.94	129.12
Probability	0.000	0.000	0.764	0.000	0.000	0.000	0.000	0.000
Sum	229.67%	225.05%	-83.82%	86.93%	42.62%	10.11%	10.46%	22.05%
Sum Sq. Dev.	0.943	0.311	0.282	0.326	0.004	0.002	0.001	0.001
Observations	614	240	71	305	614	240	71	305

	Overall	Bull1	Bear	Bull2	Overall	Bull1	Bear	Bull2
		COMMODITY				CURRENCY		
Mean	0.26%	0.64%	-0.57%	0.15%	9.70E-05	NA	NA	9.70E-05
Median	0.46%	0.91%	-0.36%	0.16%	0.00%	NA	NA	0.00%
Maximum	18.06%	6.85%	18.06%	9.29%	4.37%	NA	NA	4.37%
Minimum	-22.48%	-7.59%	-22.48%	-12.98%	-3.60%	NA	NA	-3.60%
Std. Dev.	3.35%	2.46%	6.10%	3.01%	0.77%	NA	NA	0.77%
Skewness	-0.459	-0.581	-0.079	-0.177	0.361	NA	NA	0.361
Kurtosis	9.262	3.874	5.726	4.724	11.818	NA	NA	11.818
Jarque-Bera	1024.73	21.12	22.06	39.35	547.98	NA	NA	547.98
Probability	0.000	0.000	0.000	0.000	0.000	NA	NA	0.000
Sum	161.87%	154.51%	-40.82%	47.25%	1.63%	NA	NA	1.63%
Sum Sq. Dev.	0.688	0.145	0.261	0.275	0.010	NA	NA	0.010
Observations	614	240	71	305	168	0	0	168

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Table 4.7.4c China ETF Asset Correlations Matrix

Correlation / t-Statistic / Probability	SMALL_CAP Overall	SMALL_CAP Bull1	SMALL_CAP Bear	SMALL_CAP Bull2	LARGE_CAP Overall	LARGE_CAP Bull1	LARGE_CAP Bear	LARGE_CAP Bull2	BROAD_MARKET Overall	BROAD_MARKET Bull1	BROAD_MARKET Bear	BROAD_MARKET Bull2
SMALL_CAP	1	1	1	1								
	-----	-----	-----	-----								
	-----	-----	-----	-----								
LARGE_CAP	0.730	0.769	0.638	0.748	1	1	1	1				
	26.406	18.569	6.873	19.639	-----	-----	-----	-----				
	0.000	0.000	0.000	0.000	-----	-----	-----	-----				
BROAD_MARKET	0.842	0.851	0.855	0.822	0.908	0.919	0.851	0.938	1	1	1	1
	38.666	25.029	13.672	25.100	53.551	35.951	13.465	47.139	-----	-----	-----	-----
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	-----	-----	-----
FIXED_INCOME_ BONDS	-0.030	0.031	-0.060	-0.026	-0.041	-0.018	-0.109	0.030	-0.022	0.016	-0.036	-0.002
	-0.733	0.472	-0.499	-0.445	-1.017	-0.279	-0.910	0.518	-0.541	0.247	-0.303	-0.034
	0.464	0.637	0.620	0.657	0.310	0.781	0.366	0.605	0.589	0.805	0.763	0.973
REIT	0.708	0.694	0.658	0.736	0.784	0.709	0.779	0.835	0.810	0.745	0.830	0.838
	24.806	14.856	7.256	18.922	31.271	15.496	10.319	26.433	34.158	17.241	12.370	26.716
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PRIVATE_EQUITY	0.559	NA	NA	0.559	0.481	NA	NA	0.481	0.474	NA	NA	0.474
	11.198	NA	NA	11.198	9.109	NA	NA	9.109	8.940	NA	NA	8.940
	0.000	NA	NA	0.000	0.000	NA	NA	0.000	0.000	NA	NA	0.000
COMMODITY	0.566	0.474	0.530	0.648	0.683	0.578	0.683	0.754	0.672	0.539	0.708	0.738
	16.974	8.315	5.190	14.822	23.141	10.940	7.763	19.969	22.448	9.869	8.337	19.046
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CURRENCY	0.236	NA	NA	0.236	0.164	NA	NA	0.164	0.172	NA	NA	0.172
	3.123	NA	NA	3.123	2.148	NA	NA	2.148	2.248	NA	NA	2.248
	0.002	NA	NA	0.002	0.033	NA	NA	0.033	0.026	NA	NA	0.026

Correlation / t-Statistic / Probability	FIXED_INCOME_BONDS Overall	FIXED_INCOME_BONDS Bull1	FIXED_INCOME_BONDS Bear	FIXED_INCOME_BONDS Bull2	REIT Overall	REIT Bull1	REIT Bear	REIT Bull2	PRIVATE_EQUITY Overall	PRIVATE_EQUITY Bull1	PRIVATE_EQUITY Bear	PRIVATE_EQUITY Bull2	COMMODITY Overall	COMMODITY Bull1	COMMODITY Bear	COMMODITY Bull2
SMALL_CAP																
LARGE_CAP																
BROAD_MARKET																
FIXED_INCOME_ BONDS	1	1	1	1												
	-----	-----	-----	-----												
	-----	-----	-----	-----												
REIT	-0.036	0.008	-0.095	0.004	1	1	1	1								
	-0.888	0.120	-0.792	0.069	-----	-----	-----	-----								
	0.375	0.905	0.431	0.945	-----	-----	-----	-----								
PRIVATE_EQUITY	0.081	NA	NA	0.081	0.418	NA	NA	0.418	1	NA	NA	1				
	1.355	NA	NA	1.355	7.637	NA	NA	7.637	-----	NA	NA	-----				
	0.177	NA	NA	0.177	0.000	NA	NA	0.000	-----	NA	NA	-----				
COMMODITY	-0.076	0.031	-0.268	-0.010	0.656	0.478	0.748	0.661	0.295	NA	NA	0.295	1	1	1	1
	-1.884	0.480	-2.311	-0.172	21.498	8.406	9.351	15.349	5.127	NA	NA	5.127	-----	-----	-----	-----
	0.060	0.632	0.024	0.864	0.000	0.000	0.000	0.000	0.000	NA	NA	0.000	-----	-----	-----	-----
CURRENCY	0.082	NA	NA	0.082	0.184	NA	NA	0.184	0.150	NA	NA	0.150	0.055	NA	NA	0.055
	1.066	NA	NA	1.066	2.407	NA	NA	2.407	1.954	NA	NA	1.954	0.711	NA	NA	0.711
	0.288	NA	NA	0.288	0.017	NA	NA	0.017	0.052	NA	NA	0.052	0.478	NA	NA	0.478

Error! Unknown **switch argument.**

4.8 Overarching Themes and Conclusions

Overall the first result to emerge is that weekly returns seem to follow a leptokurtic distribution with negative skew. This means the distribution is higher peaked with fatter tails than a normal distribution; meaning there is a higher chance of extreme values.

The most lucrative assets overall were Small_Cap and REITs generally with Fixed_Income the most stable asset judging by weekly standard deviation.

The hypothesis will now be restated and evaluated in turn in the light of the evidence.

Main hypothesis: *ETF asset correlations change depending on Bear and Bull markets*

Generalising, correlations did broadly follow the same pattern in each geographic market; Figure 4.8a shows the correlation-return heat maps for all developed markets and Figure 4.8b displays the correlation-return heat maps for the undeveloped BRIC markets. Small_Cap, Large_Cap and Broad_Market have very strong correlations, as to be expected. Equity correlations against REITs and Private_Equity are strong but less so. Fixed_Income correlations are very weak against all other assets, displaying their justification to be a major asset in diversified portfolios.

Between Bear and Bull markets evidence suggests that correlations are higher in Bear markets than Bull markets. In the U.S. this can be seen between equities against Fixed_Income and equities against REITs; in the Global market between equities and Fixed_Income. It is hypothesised that part of the reason for these correlation changes is due to investor rebalancing their portfolios during Bear markets, escaping risky equities and purchasing the low risk Fixed_Income assets.

To conclude, for the most part ETF asset correlations are stable between Bear and Bull markets, but limited evidence is found showing correlations strengthening during Bear markets. Stable correlations point towards the ETF market allowing portfolio construction with efficient diversification over a number of assets. In short, ETFs allow a low-cost diversified portfolio

containing major asset classes. It is worth noting that Pearsons correlation will only identify linear correlations and a correlation near zero just means that no linear correlation is present.

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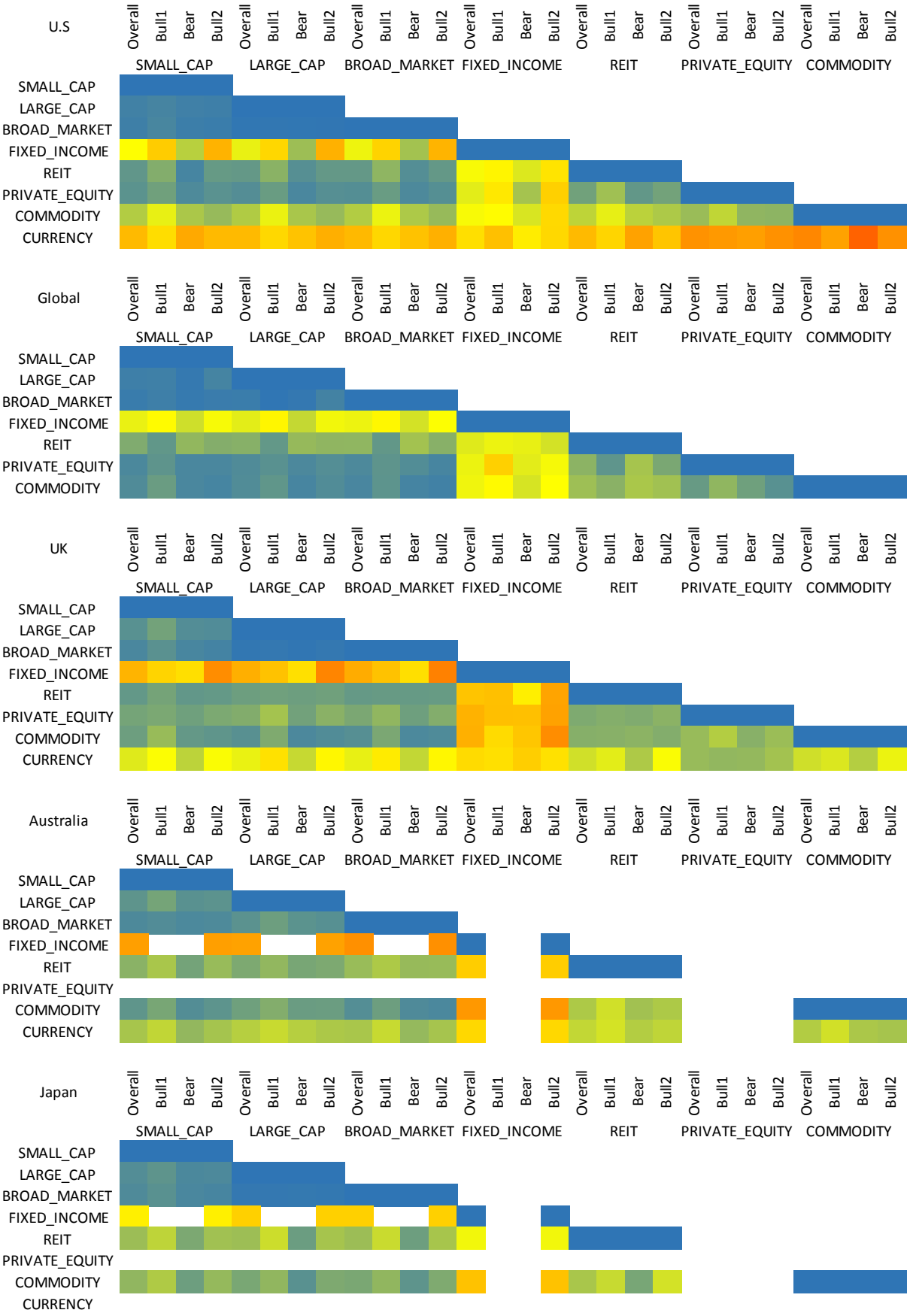
Figure 4.8a Developed Market Correlation-Return Heat Maps



Perfect negative correlation

-1

0

Perfect positive correlation

Error! Unknown **switch argument.**

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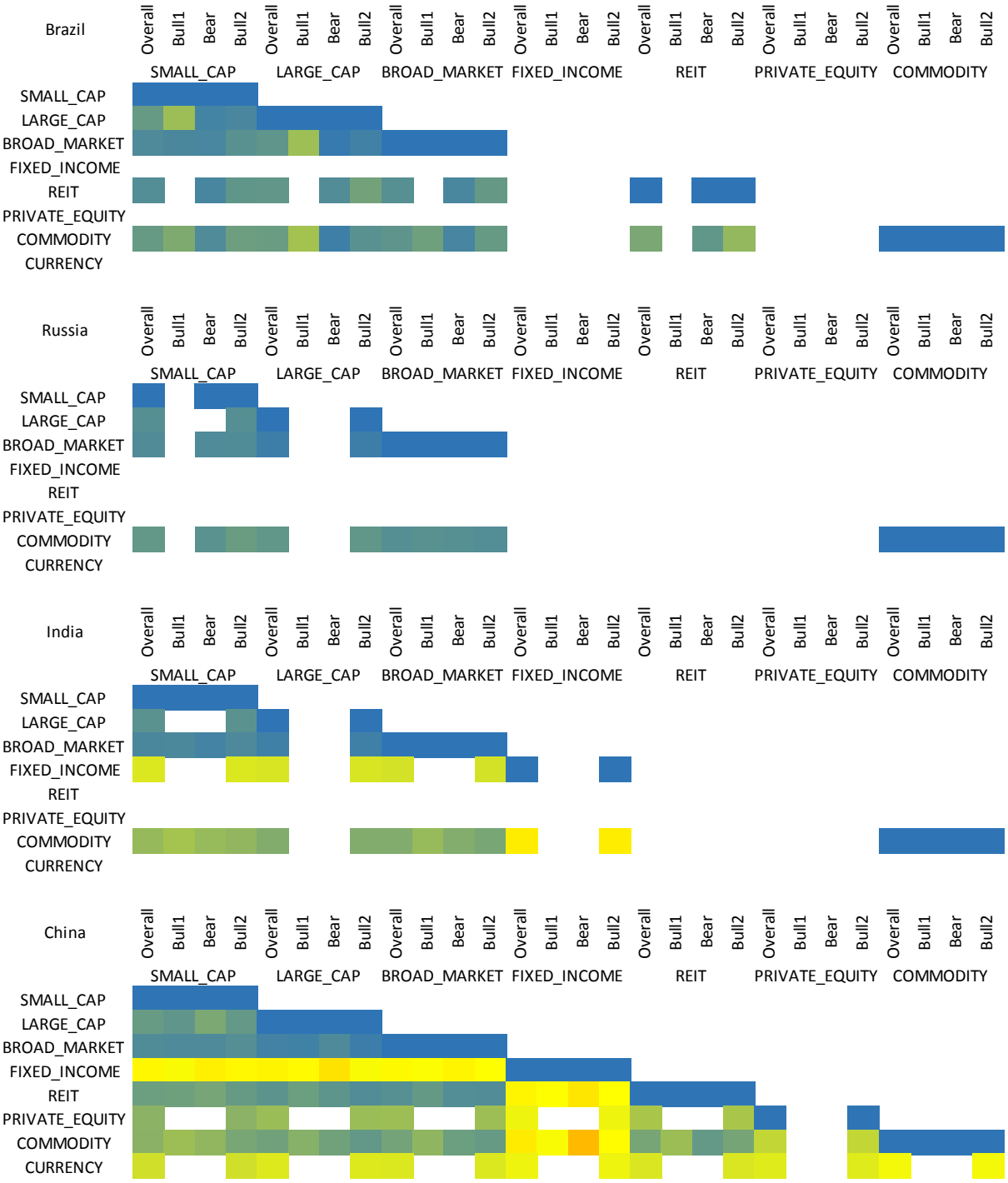
Figure 4.8b Undeveloped Market Correlation-Return Heat Maps



Additional hypothesis 1: *ETF assets show that to achieve higher returns greater risks must be taken (risk premia).*

The main evidence for evaluating the hypothesis is the Risk/Return graphs constructed for each geographic market. U.S., Australia, Japan, India and China all display evidence that greater returns necessitated taking greater risk. The Global, UK and Europe markets would also display this trend if limited data assets had been omitted.

A strong reason for the risk-return relationship persisting for so many markets is that Fixed_Income so commonly had very low weekly risk and returns, generally far away from other assets with both greater risk and return.

Additional hypothesis 2: *Small cap equities behave differently to Large Cap equities*

In terms of correlations this hypothesis must be rejected. Small_Cap and Large_Cap had very similar correlations to other assets studied overall and in Bull and Bear market types. The only difference notable in this data set is that Small_Cap assets tend to consistently make greater returns than their Large_Cap counterparts. Additionally, on a vast majority of Risk/Return graphs, Small_Cap lies above the trend line and Large_Cap lies below pointing towards Small_Cap being more risk efficient than Large_Cap. A more thorough analysis will need to be conducted to confirm this.

5. Conclusion

The dissertation set out to answer the research question: do ETF asset class correlations change under Bear/Bull equity markets? Changes would only be noteworthy if they are consistent under a majority of markets, and would be important for investors wishing to construct diversified portfolios using only ETFs. It is important to note that for investors the market types have to be identified or predicted to understand how correlations are likely to change in the future. It is simple to do and select the point where a Bull market became a Bear in retrospect. However, ex-post this may be near impossible and once the market type has been recognised it might be extremely difficult to rebalance portfolios effectively and take advantage of the asset classes that still generate returns during a Bear market.

In each market major asset returns were calculated using ETF and index data from 2003 (one year after the ETF boom in 2002) to 2014. Assets included were equities (split into small, large and broad market capitalisation), fixed income, REIT, Private Equity, commodity and currency. A range of geographic markets were analysed including the U.S., UK, Australia, Japan, Europe, Global and BRIC countries. In several areas ETF asset data was limited and therefore correlation matrices were incomplete. Once weekly returns for each asset in each market were collected, Pearson correlations were calculated overall. Then the time period was split into two Bull markets and a Bear market and correlations calculated again. The Bear and Bull markets were identified using global MSCI equity indices and correspond to the periods before, during and after the 2008 financial crisis.

Through the course of the work a common asset feature hoped to be found was greater returns required taking greater risks and that small cap equities behaved in a different way to Large Cap equities.

The work featured here does not support the hypothesis that asset correlations change under differing market structures. With the only evidence being a slight increase in return correlations in the Bear market. Most commonly this was seen between equities and fixed income assets, and the

correlation changes were likely to be a result of portfolio rebalancing by investors away from equities into fixed income assets. The result that correlations appear stable between assets is a strong indicator that ETFs are representative of their underlying assets and therefore can be used to construct a highly liquid diversified portfolio. These portfolios can easily include a range of assets at low expense ratios.

Equities were split into Small and Large capitalisation sizes to extend analysis and found to have very similar correlations to other asset classes overall and during Bear and Bull markets. The descriptive data between Small and Large Caps points towards small caps not only generating higher returns over time but also being a more risk efficient asset.

The fixed income asset classes was found to have very low return correlations with other major assets in both Bull and Bear markets. Along with its low weekly standard deviation and consistent (but low returns) it is clear to see why investors choose fixed income as an asset to diversify away from equities.

REIT and Private Equity assets both made reasonable returns, often in line with small cap equities but Private Equity expense ratios were much higher than REITs. Correlations against equities were high but not perfectly correlated, meaning that diversification benefits still exist. Therefore investors should avoid Private Equity ETFs and use REIT ETFs in a diversified passive investment strategy.

6. Recommendations

6.1 Factor-based investment

A sensible extension is to consider correlations between factors rather than assets for example the Fama and French (1993) factors such as growth and value. This is an area of investment that is strongly developing and many investment professionals now use factor-based portfolio development and management. Therefore there is value in considering correlations between different factors under differing market structure.

6.2 Market types

The market types considered were very basic and could be improved upon. For example more varied market types, including low or high volatility markets. Other market factors could also be included such as inflation, unemployment, liquidity, and growth. Growth would especially useful in country specific markets since periods of growth could be contrasted to periods of recession.

6.3 Fixed Income Assets

It was noted in the literature review that the Bonds and Fixed Income asset class was over simplified and could be expanded upon in future work. To expand the asset class, it seems sensible to separate corporate and government bonds of the same maturity to see if correlation differences exist. Another area for exploration is Bonds which do not meet investment grade standards (junk bonds) and therefore advertise higher returns for investors. These bonds can be highly volatile and largely affected by market conditions. It's likely the 'flight to quality' effect (which classically in in favour of bonds) may be reversed and investors will sell these risky bonds in favour of their investment grade counterparts. Given the conclusions that the fixed income asset class correlations were mostly uncorrelated with other asset classes, including other bond types and splitting up the aggregate ETF could yield significant correlation changes. Work into this area would be important since bonds make up a significant weight (in the same region as equities) in most portfolios. Also, the correlation analysis revealed their

unique properties compared to other asset classes: specifically positive returns in Bear markets, low standard deviations and return correlations that tend to decrease in Bull markets.

Additionally, maturities could be split into categories such as short-term (<5 years); intermediate-term (5-10 years) and long-term (>10 years). Investors generally choose their maturity with care, either aiming for lower/higher risk or less/more interest rate sensitivity.

6.4 Developing Markets (BRIC)

As was seen in data collection and correlation analysis the data for developing (BRIC) markets was limited, leading to the exclusion of South Africa and not allowing for full correlation analysis for all assets. Therefore a clear area for expansion is a repeat of the study when more data is available. Doubtless ETF markets will continue to develop and the relevant ETF and indices will be constructed in time. Once full data is collected a fuller analysis may be given comparing developed and developing markets to distinguish persistent differences with a higher degree of certainty.

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